RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

VOL. VII SEPTEMBER, 1926 No. 3

THE STUDY OF THE HEART ACTION WITH THE ROENTGEN CINEMATOGRAPH

By W. EDWARD CHAMBERLAIN, M.D., and WILLIAM DOCK, M.D.
SAN FRANCISCO
From the Departments of Radiology and Medicine, Stanford University Medical School

CINEMATOGRAPHIC roentgenography of the human heart has been accomplished by two principal methods. Photographing with cinema films the image on the fluorescent screen was first accomplished (1) and recently brought to a high degree of perfection (2) by Lomon and Commandon. Full-size roentgenograms of the human heart, taken at fixed instants in the cardiac cycle (3, 4) or in rapid succession (5, 6) have not been of great value until Ruggles (7), with the assistance of Mr. E. P. Fletcher, designed and operated a machine taking fifteen 8×10 in. instantaneous roentgenograms per second. The cinematographic positive prepared by them left nothing to be desired in the sharpness of projection of the motions of the heart, but it is questionable if such a method has any advantage over that of Lomon and Commandon for demonstration or preservation of fluoroscopic findings. Its disadvantage, for such work, is the greater cost and difficulty of operation.

For the more important purpose of analyzing the action of the normal and diseased heart the method of Ruggles is indispensable, for it is impossible to measure accurately films in which the borders are even slightly blurred, as occurs in full-size projections of photographs of the fluorescent screen image. Thanks to the generosity of Dr. Ruggles, of the University of California, we have had an opportunity to measure his original films of the normal heart and to use his machine, with the assistance of Mr. Fletcher, to obtain for similar analysis films of the moving heart border in cases of valvular disease.

THE MACHINE OF RUGGLES AND FLETCHER

Regular Eastman Superspeed Duplitized X-ray Film, in strips 8 inches wide and 30 feet long, is drawn through the exposure frame by rubber-covered rollers for a distance of eleven inches, while a mechanism of eccentrics and connecting rods holds the two intensifying screens apart and releases a pair of brake shoes designed to prevent movement of the film during the making of each exposure. When the film has moved eleven inches, the rubber-covered rollers no longer grip it firmly between them, for they are broadly notched, and the brakes are at this instant applied to the edges of the film. The intensifying screens are then forced together, and the new area of film is in place and ready for exposure. The above train of events occupies a total time of approximately 1/24 second. During this interval the high tension line between the X-ray machine and the X-ray tube has been discon-

nected by a high tension oil-immersed switch, interposed in the anode line. This switch is operated by a shaft from the rollers which move the film.

At the instant that the intensifying screens make contact with the film, the high tension oil-immersed switch closes, remaining so for 1/40 second. The switch then opens again, the intensifying screens separate, the brakes are released, and the rotating rubber-covered rollers again grip the film to draw it forward another eleven inches. It will be seen that the above cycle is repeated every 1/15 second, the moving and stopping of the film requiring 1/24 second, and the exposure 1/40 second. Four lead markers are affixed to the front of the exposure frame so as to cast sharp shadows upon each roentgenogram. These are necessary in order that consecutive films may be exactly superimposed, whether for cinematography or for measurement of movement.

An important addition to the original design proved to be a tiny metallic point projecting from the surface of one of the rubber-covered rollers. This serves to mark the dividing line between each "frame" and the next succeeding one. The small dent in the film can be felt in the dark room, and the film is cut off and trimmed to 8×10 inch size, for development in a standard film-developing hanger. The serial number of each picture is written on its margin in pencil as it is cut off.

We recorded the actual timing of the cinematographic cycle, and proved that it actually occupied 1/15 second, by attaching a small switch to the mechanism, to close a 3-volt dry-cell-operated circuit for a part of each cycle. The current thus supplied operates a solenoid and ink recording pen on a McKenzie polygraph. Time, in fifths of a second, is recorded simultaneously on the same tape, and it is possible to obtain pulse tracings on the same record. On account of the variable phase difference between the sphygmographic cycle and the actual heart cycle, we have not considered the pulse tracing important. As pointed out by Ruggles in the original demonstration of his motion picture (7), arrangements should be made to record the exact instant of each exposure directly upon the electrocardiogram. The technical difficulties in the way of accomplishing this are not serious (3).

PROCEDURE

The machine is necessarily quite noisy, and in its present form must be operated in a room lighted only by a safe light. We therefore use care in acquainting the patient with the apparatus and procedure. He is carefully coached to hold his breath and remain immobilized, and before the running of the new film, trial runs are made in order to accustom him to the noise and darkness. To facilitate centering the heart shadow in the 8×10 inch frame, the patient has been fluoroscoped, and the heart outlines have been marked upon the anterior chest wall by an orthodiagraphic method.

After the final run, the exposed film is removed to the dark room where it is cut, trimmed, numbered serially, and placed in regular 8×10 inch film-developing hangers. The finishing and drying of the film is routine.

The finished films are arranged in sequence, beginning with the first exposure. A sheet of clear celluloid is firmly held over the first film, on a light box, and the outlines of the lead markers are carefully traced with a sharp style. These markers make it possible to place the celluloid sheet in correct registration on each film. Lines are then drawn on the celluloid perpendicular to the heart border at various points whose motion we wish to follow; these lines are 1.5 cm. long and are marked at 1 mm. intervals with cross lines. The position of each point on the border with reference to the outer end of its line is then measured

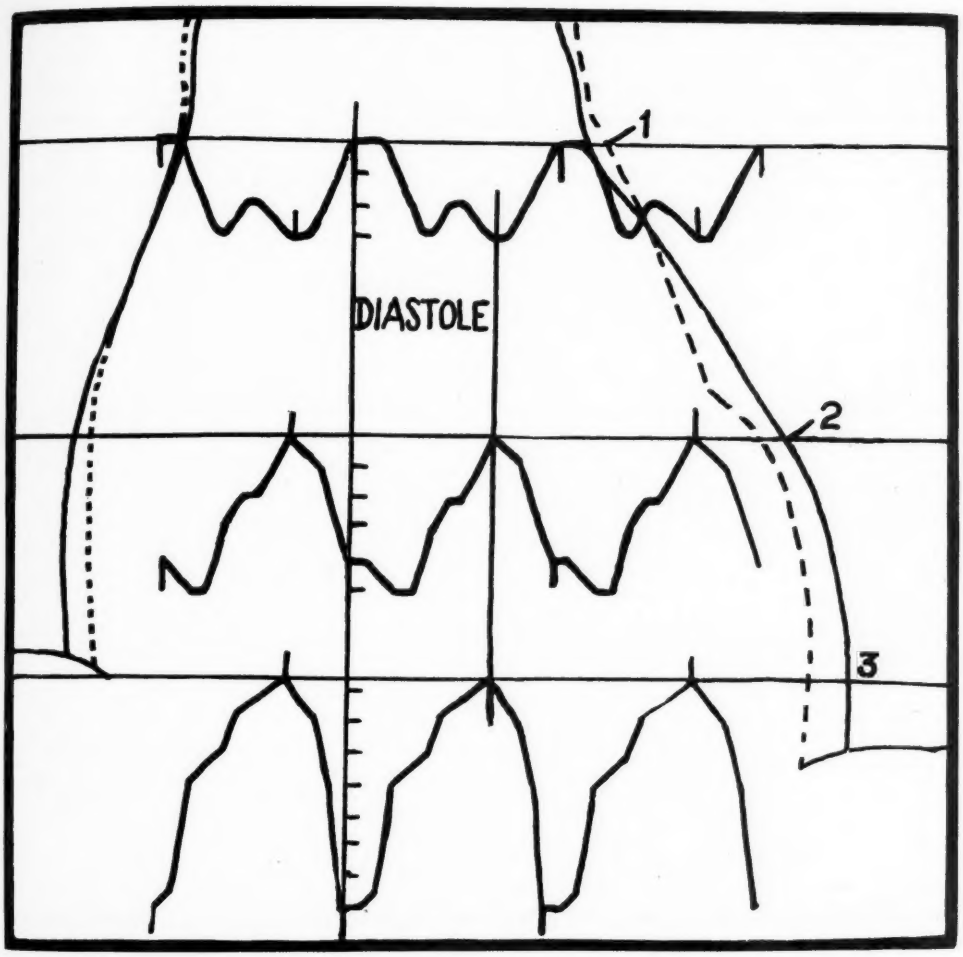


Fig. 1. Frontal projection of the normal heart, at end of diastole (heavy lines) and at end of systole (dotted lines), together with skiacardiograms at the points indicated by the numbers. The maximum auricular excursion (Point 1) is 3 mm. Maximum ventricular excursion (Point 3) is 7.5 mm. Duration of diastole is 9/15 second. Duration of systole is 4/15 second. An up-stroke marks the beginning, a down-stroke the end of systole.

and recorded. With this method quick and accurate measurements are easily made and recorded, to the quarter-millimeter; the maximum deviation in repeated measurements is not greater than a quarter-millimeter and averages about 0.1 mm. The second film is lined up under the markers in the same way and the measurements recorded from the mm. scales. In this way the entire series is measured. The movements of the points on the heart border are then graphically charted, the distance of the border from fixed points on lines perpendicular to the border forming the ordinates, and the time, 1/15 second for each film, the abscissæ.

Before adopting this method we tried planimeter measurements of analogous areas, and measurements with dividers along lines drawn on celluloid sheets from

the midline across various points on the heart border. The errors introduced in such measurements are great, and curves obtained in this way were less satisfactory than with the method described.

RESULTS

We found at once that without examining many points on both right and left borders only very unsatisfactory relationships could be determined. We therefore projected Dr. Ruggles' film so that we could mark the position of the nodal point on the left border with reference to the markers. We transferred this to our celluloid sheet and measured the left border at 1 cm. intervals above and below it. We also measured the right border at 1 cm. intervals.

The caudal 5 cm. of the right border moved in phase with the apex, although its diastolic filling began 2/15 second later. The next 3 cm. moved less than 1 mm. and may be considered the nodal area; the next 2 cm. moved in phase with the left auricle. The relation of the three most significant points on the left border is shown in the graph (Fig. 1). None of the curves correspond with the conventional curves of volume determined with the plethysmograph, but are not unlike myographic curves of the heart. The auricle empties early in diastole, giving only a slight deflection with auricular systole. The right ventricular border and the upper 5 cm. of the left ventricular border begin to move out 2/15 second later than the apex, and actually move in in early diastole. This could be predicted of an elastic oval bag being filled by a stream directed along its long axis.

Our curves in the normal and in two cases of mitral valve disease show clearly that most of the right border moves as ventricle. This is opposed to the assumption given in many texts on heart disease and on roentgenology. Assmann (12) states that in expiration the right border is largely auricular, in deep inspiration largely ventricular. Our films were all taken in the latter phase, which may explain our finding. At any rate it cannot be assumed off-hand, as has been done by those who have used the slit and moving film to study the motion of the heart border (8, 9, 10, 11), that the right border is auricular. About 2.5 cm. of the left border showed auricular motion.

SUMMARY

A method is described for analyzing the motions of the heart from films obtained with the roentgen cinematograph of Ruggles.

The skiacardiograms thus obtained give the following information:

The normal left auricle empties early in diastole and shows only very slight motion at auricular systole.

At the beginning of diastole the cephalic half of the normal left ventricular border may move mesad for as much as 2/15 of a second after the apex has begun its diastolic excursion.

The caudal 5 cm. of the normal right border moves in phase with the left ventricle. Only about 2 cm. of the cephalic part of the right border moves in phase with the auricle.

REFERENCES

1. Lomon and Commandon: La radiocinématographie par la photographie des écrans renforçateurs. Bull. et mém. Soc. radiol., April 11, 1911, III, 127-134.
2. Lomon and Commandon: La cinématographie radiologique. Jour. de radiol. et d'electrotherap., Oct., 1924, VIII, 433-437.
3. Eyster, J. A. E., and Meek, W. J.: Instantaneous radiographs of the human heart at determined points in the cardiac cycle. Am. Jour. Roentgenol., Oct., 1920, VII, 471-477.
4. McPhedran, F. M., and Weyl, C. N.: Automatic synchronization of roentgen-ray exposures. Am. Jour. Med. Sci., April, 1925, CLXIX, 510-516.
5. Groedel, F. M.: Die Tecknik der Röntgenkinematographie. Deutsch. med. Wchnschr., 1909, XXXV, 434-435.

6. DESSAUER: Weitere arbeiten auf dem gebiete der Butz aufnahmen und der Röntgenkinematographie. Zentralbl. f. Herz. v. Gefasskrankheiten, 1912, IV, 349.
7. RUGGLES, H. E.: X-ray motion pictures of the thorax. Radiology, Nov., 1925, V, 444 (Preliminary program, Eleventh Annual Meeting, Radiological Society of North America).
8. GÖTT, TH., and ROSENTHAL, J.: Veber ein Verfahren zur Darstellung der Herzbewegung mittels Röntgenstrahlen (Röntgenkymographie). München. med. Wchnschr., 1912, 59, 2033-2035.
9. BECKER, TH.: Die Analyse des Electrocardiogramms mittels der Röntgenkymographie. Deutsch. Arch. f. klin. Med., 1914, CXIII, 216-225.
10. CRANE, A. W.: Roentgenology of the heart. Am. Jour. Roentgenol., 1916, III, 513-524.
11. COHN, A. E., and STEWART, H.: Evidence that digitalis influences contraction of the heart in man. Jour. Clin. Invest., Oct., 1924, I, 97-125.
12. ASSMANN, H.: Klinische Röntgendiagnostik der inneren Erkrankungen. Leipzig, 1924, p. 8.

THE ROENTGEN-RAY FINDINGS IN A SERIES OF CASES OF HEADACHE

By PROF. ARTHUR SCHÜLLER, M.D., University of Vienna, Austria

TRANSLATION BY HENRY R. WOLCOTT

IT is a generally recognized fact that there are many causes of headache. It will occasion no surprise, therefore, that the roentgen-ray findings in cases of headache present usually a wide range of variation. It happens not infrequently, however, that a roentgenogram, even in cases of very severe and obstinate headache, gives a negative result. That is particularly true of the various types of nervous cephalalgia (in neurasthenics), and likewise of headache associated with vasomotor disturbances, which are caused by anemia, by venous stasis in heart and lung diseases, or by congestions. The conditions are similar in toxic headaches resulting from intoxicating poisons; in auto-intoxications of gastro-intestinal, uremic and diabetic origin, and in infectious diseases. Finally, there should be mentioned, in this connection, the traumatic headache.

If the positive roentgen-ray findings in cases of headache are classified according to the anatomic changes visible in the roentgenogram, one may distinguish destructive and hyperosteogenic changes in the cranial bones, modifications in form and size of all (or of certain portions of) the skull, changes in the vascular grooves and sutures, residua of traumatic action on the skull, affections of the accessory sinuses of the nose, and, finally, focal or diffuse changes in the interior of the skull. The various types of headache, in which, frequently, positive roentgen-ray findings may be recorded, may be classified in the following groups: (1) syphilis and various other inflammations, also neoplasms of the skull; (2) traumata of the head; (3) organic affections of the brain and meninges; (4) affections of the cerebral arteries, and (5) affections of the accessory sinuses of the cranium.

I will begin with a description of certain changes in the cranium in syphilis which so often give rise to obstinate headaches. One of the most frequent pictures is that of circumscribed osteoperiostitis of the cranial dome. It occurs in single or multiple foci, being particularly common in the region of the tubera. The size of the foci varies from that of a finger nail to that of the palm of the hand. In the roentgenogram the foci appear as light colored spots. Viewed in profile (in tangential photographs) the contour of the lamina externa and the lamina interna appears jagged or dentate, while the diploë presents irregular shades of light and dark. Sometimes one sees, in addition to the described osteoporotic foci, two other types of syphilitic bone destruction; namely, the transparencies produced by gummata, roundish or kidney-shaped, not sharply circumscribed, defects, and reticular transparencies, which correspond to the ramifications of the diploic vein channels of the cranial dome, since the syphilitic granulation tissue shows a predilection for the course along the channels of the diploë and attacks the bones bordering on those channels. Less frequently than the osteoporotic type, we find the hyperosteogenic type of cranial syphilis revealed in the roentgenogram. It is shown by a condensation and slight thickening of circumscribed portions of the wall of the cranial dome (tophus syphiliticus), or by delicate periosteal bone thickening of the lamina externa, corresponding to syphilitic periostitis.

There is frequently, however, a certain unevenness revealed by profile roentgenograms of the heads of normal persons, which bears a close resemblance to the periosteal syphilitic deposits, so that often a false diagnosis of a syphilitic affection is

reached. There are two places especially that may give rise to such an error; namely, the jagged contour of the sagittal suture at the apex of the crown of the head and the prominence of the external surface of the

Fig. 1. Luetic osteitis.

squama occipitalis. In the anteroposterior view, the squamosal suture may give rise to an error, since the upper margin of the squama temporalis is set off from the lamina externa of the parietal bone as a thin periosteal bone lamella. However, as the two sides present a symmetrical appearance, the differentiation from syphilitic periostitis does not usually offer any difficulties.

All the local changes previously described may occur combined in the same person. In addition, there is a generalized osteosclerosis of the cranial dome in syphilis, the cranium, at the same time, being usually abnormally large and broad. This type seems to occur especially in congenital syphilis and appears to be associated with syphilitic hydrocephalus that has healed.

In a considerable number of cases that I examined headaches of great intensity had existed for many years, until, on the basis of the roentgenogram, they were interpreted as of syphilitic origin, whereupon a cure

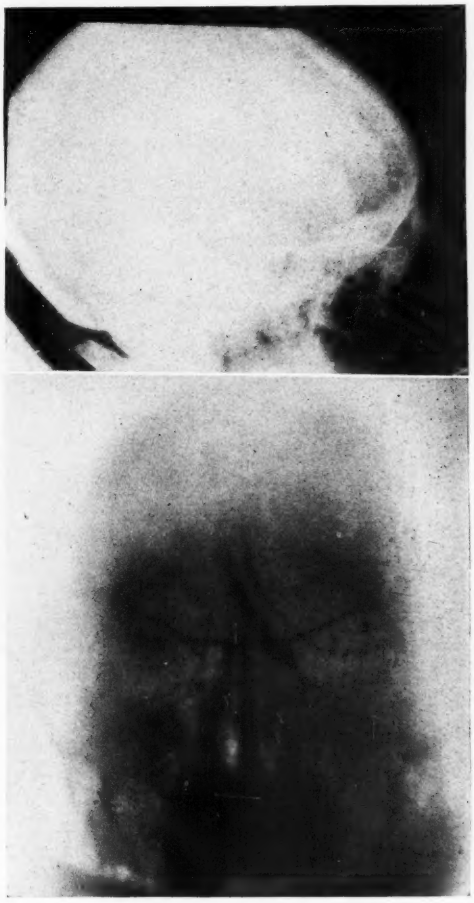


Fig. 2 (above). Luetic periostitis.
Fig. 3 (below). Luetic osteitis.

was effected in a short time by the use of iodin. In several of the foregoing cases the headache was supposed to be associated with hysteria, or to be of nervous origin. In other cases, it was referred to an affection of the accessory sinuses of the head, and an endeavor was made to bring relief through operative intervention. In one of my cases

eight operations on the accessory sinuses of the nose and on the mastoid processes had been performed, until finally the roentgen-ray examination revealed an advanced stage of a syphilitic affection involving almost the whole cranium.

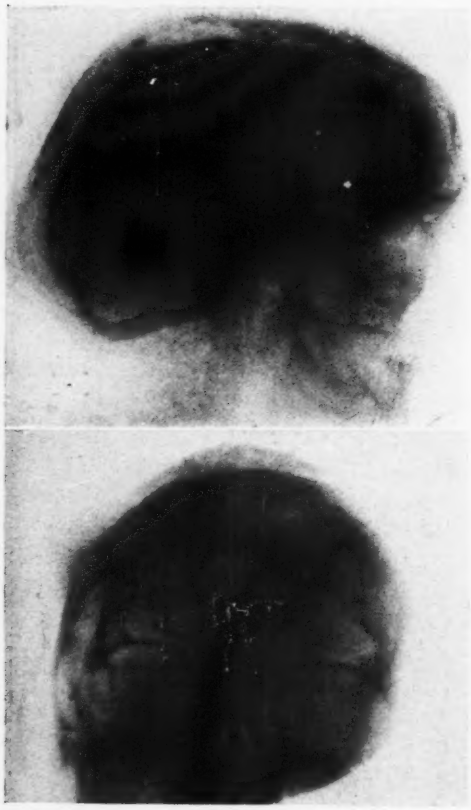


Fig. 4 (above). Osteitis deformans (Paget's disease). (See p. 193.)
Fig. 5 (below). Osteoma. (See p. 193.)

In comparison with syphilitic osteitis, the other inflammations of the cranial bones occur but seldom: tuberculous osteitis, which is represented in the roentgenogram in the form of indistinctly outlined, solitary defects, which affect usually only the external or the internal layer of the cranial dome without penetrating the bone entirely. Also in the immediate vicinity of the defect slight transparencies may be visible, corresponding to the progression of the carious process on the surface. At the base of the skull, in the region of the sphenoid bone and the petrous portion of the temporal bone, tuberculosis produces indistinctly outlined transparencies, in the vicinity of which is a large transparent area. Congenital deformities of this region, which give rise to a "basilar impression" and to neuralgia of the occipital nerve, bear a great resemblance to tuberculous destructions in the atlanto-occipital region (Pott's disease).

In the same manner as the enumerated chronic inflammatory affections of the skull, the changes that are produced by acute osteomyelitis of the cranial bones can be determined by roentgenograms. In that category we include bone degeneration caused by mastoiditis. It is manifested by a lighter area bounded by an indistinct and irregular line within the cellular structure of the mastoid, especially in connection with the degenerations produced by the *Bacillus mucosus.* Much less frequent is osteomyelitis of the cranial bones due to the spread of the inflammation from the accessory nasal sinuses. I may mention osteomyelitis that develops following penetrating injuries of the skull and the localization of acute infectious osteomyelitis in the region of the cranium. In case of the latter, extensive defect areas with irregular margins and sequestra separated from their place of origin are seen in the roentgenogram.

The next group comprises the cranial changes in osteitis deformans (Paget), osteitis fibrosa (Recklinghausen) and tumors of the cranial bones. The foregoing affections cause headache either through compression of the branches of the trigeminal and occipital nerves or through increase of intracranial pressure. Paget's osteitis deformans, which, of all the bones of the skeleton, shows a predilection for the skull, is found chiefly in elderly persons. The characteristic clinical symptoms are: increase of

the circumference of the cranium, deformation of the head, headache and psychic disturbances. In the roentgenogram (Fig. 4) it is easily recognized by the following symptoms: (1) thickening of the cranial dome; (2) diffuse osteoporosis with infiltration of sclerotic bone islets, and (3) impression of the frame of the occipital foramen against the cranial cavity.

In osteitis fibrosa and in tumors (osteomas and osteosarcomas) of the skull bone (Fig. 5) are found, for the most part, circumscribed thickened patches of the cranial wall, some of which extend outward and some inward. Not infrequently, the roentgenogram reveals also destruction of the skull bone due to metastases of carcinomas in distant organs; for example, the mammary gland, the prostate or the thyroid gland. The defects produced by metastases in the region of the cranial dome are chiefly circular or oval, and multiple. At the base of the cranium, the os basilare and the os petrosum are a predilection site for the lodgment of metastases, which are manifested as spotted transparencies or extensive destructive changes in the parts mentioned. Manifestations similar to the metastases of carcinomas are encountered in connection with myelomas, which in the skull, as well as in all other parts of the skeleton, produce sharply outlined depressions ranging in size from that of a millet-seed to that of a cherry. Only occasionally the depressions run together to form more extensive defects (Fig. 6). Finally, also tumors of the external soft parts may produce destructive changes of the cranial bones, either infiltrations, as in carcinomas and sarcomas (Fig. 7) of the soft parts, or pressure ulcerations, as in benign tumors (atheromas, dermoids, angiomas). In connection with the discussion of the inflammations and tumors of the cranial bones, mention must be made of certain peculiar forms of hyperostosis of the cranial bones; namely, leontiasis ossea and "circumscribed osteosclerosis." They usually develop very slowly in juveniles and cause an increasing deformity, degenerative changes, generally intense headache and dis-

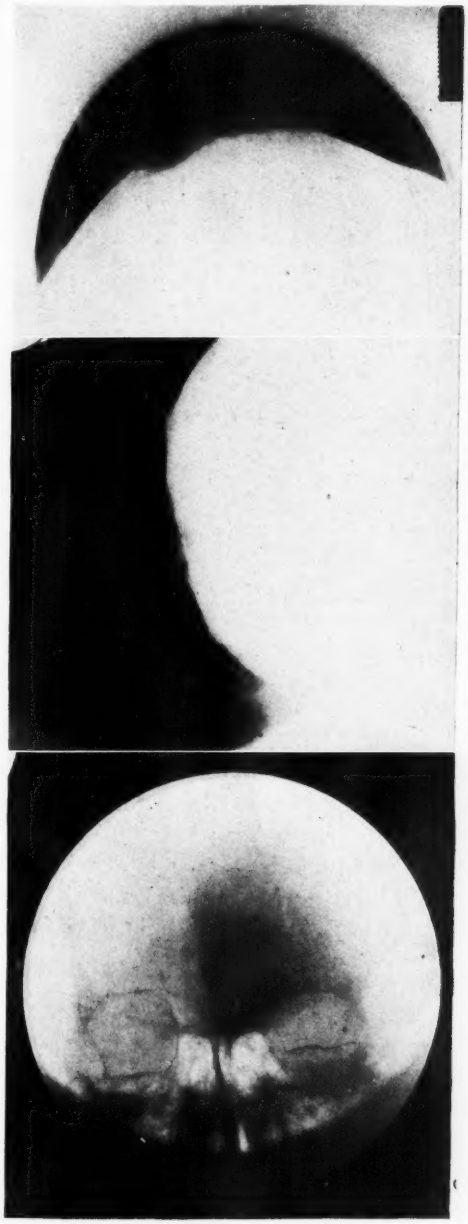


Fig. 6 (above). Myeloma.
Fig. 7 (middle). Sarcoma.
Fig. 8 (below). Circumscribed osteosclerosis of the right frontal bone. (See p. 194.)

turbances of the organs of the senses. In leontiasis ossea the characteristic symptom is nodular and diffuse thickening of the whole skull. In circumscribed osteosclerosis (Fig. 8) there is a condensation, or eburnation, and usually only a slight thickening of a single cranial bone in its whole anatomic extent. In unpaired bones, sometimes only half is affected, or, on the other hand, symmetrical bones are attacked by the affection; for instance, the two maxillæ.

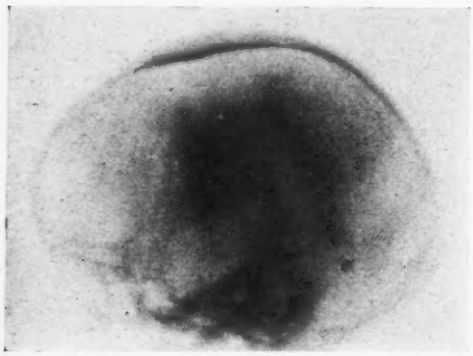


Fig. 9. Calcified meningioma with localized hyperostosis.

A few words may well be devoted to changes in the skull bones in certain forms of diffuse sarcomatosis; for instance, chloroma and leukemia. The condition is marked, on the one hand, by diffuse osteoporosis of the cranial wall; also by the formation of extensive periosteal bone deposits of radiate structure. These deposits at times take on a very peculiar form, which, so far, has been observed only in America, where the affection is called "sickle cell anemia." The radiate structure is, however, not peculiar to leukemic and sarcomatous bone thickening. It occurs also in osteomas and in localized hyperostosis, which often develop on meningiomas (endotheliomas of the dura mater). (Fig. 9.)

In the next group I will discuss headaches that arise following cranial injuries. The roentgen-ray findings in these cases are of a manifold nature. Not infrequently, in cases in which, on the basis of the complaints of the patient, the diagnosis "traumatic neurosis" had been reached, I was able to note extensive fissures, in the roentgenogram, and that not only immediately following or a short time after the trauma, but even months or years afterward.

Occasionally, too, when examining patients who complain of headache of unknown origin, we find extensive fissures of the cranial wall or foreign bodies in the interior of the skull; for instance, nails (Figs. 10 and 11), knife blades or projectiles. That the patient knows nothing of the injury is explained by the fact that he was very young at the time of the trauma or that he suffered the injury when in a condition of disturbed consciousness (for instance, when intoxicated or during a psychosis). It is possible, too, that, as a result of the injury, he was affected by a retrograde amnesia. Some of the cases may be explained, too, by the assumption that the trauma was due to an injury inflicted with suicidal intent, for which reason the patient disclaims all knowledge of the occurrence.

An interesting roentgen-ray finding is often encountered as the result of separation of parts normally continuous (fissures or penetrating wounds), which occurred in early youth. The fissures have not been filled with bony tissue, but, on the contrary, they have given rise to large cranial defects, the margins of which have become thin and project outward. The soft parts that cover the defect usually show distinct pulsation. The large defects owe their origin in the majority of cases to intracranial cystic collections of fluid, which, corresponding to the site of the injury, have formed from extravasated blood (meningocele spuria traumatica). (Fig. 12.) Such cases, when an examination is made on account of headache, are usually wrongly diagnosed. As the defects have developed gradually from the

time of youth over a period of many years, the patients often remember nothing as to their traumatic origin. The defects, therefore, are usually diagnosed by the physicians consulted as of syphilitic or tuberculous origin.

Further positive roentgen-ray findings in headache following injuries of the skull are noted in the form of local thickened areas of the cranial wall on the site of healed pressure fractures. Such thickened areas due to callous formation are, however, not of common occurrence, since skull fractures generally show little tendency to form callus.

An important thing to determine, of course, is whether the severe headaches that develop in later stages after penetrating skull injuries, and, more especially, after gunshot injuries, are caused by a brain abscess. Evidence for the presence of an abscess is furnished if the signs (to be discussed later) of increase of intracranial pressure be noted in the roentgenogram of the cranium, or if bone or projectile splinters can be demonstrated in the interior of the cranium. The foreign bodies located in centers of degeneration or in brain abscesses give occasionally, in connection with fluoroscopy or in roentgenographic examination, evidence of changing position (pulsation, migration). In recent years, the injection of air into the interior of the cranium for the demonstration of brain abscesses has been employed, after the Dandy method. Also the calcifications, which develop not infrequently in the brain scars that have arisen from degenerated traumatic areas, may be noted in roentgenograms as dense, irregular and sharply outlined shadows (brain stones). In rare instances, one can demonstrate, in fractures at the base of the skull, the presence of air within the cranium (pneumocranium).

The next group of affections in which the roentgenogram furnishes valuable diagnostic findings are intracranial tumors and other intracranial processes that increase brain pressure. As for the kind of headache that is caused by increase of blood pressure, it is either an obstinate, uninterrupted, continuous pain, or the pain comes and goes in the form of short attacks, being frequently

Figs. 10 and 11. Foreign body (nail) in center of skull. (See p. 194.)

unilateral and associated, for the most part, with vomiting (migraine). Less frequently the headache has a neuralgic character; especially if the trunk or a branch of the trigeminal nerve is directly affected by the pressure.

As is well known, two main groups of processes that increase brain pressure may be distinguished: (1) in which increase of the intracranial content is the cause of the disproportionate relations between the cranium and the brain, and (2) the group in which, with normal content, the cranium is

too small (craniostenosis). In the second group there has usually been a reduction of cranial capacity due to premature synosteosis of the sutures either *in utero* or in the first years of life; less frequently, there has been a thickening of the interior surface of the cranium. The first group is constituted by tumors of the brain, the meninges and the appendicular glands of the brain; also by hydrocephalous collections of fluid. The signs of the aforementioned affections to be found in the roentgenogram are, in part, the expression of local changes in the tumor, and, in part, the results of increase of brain pressure. The local changes are: superficial ulcerations and projections of the cranial wall, local thickened areas in the cranial bones, and local distentions of veins and calcification foci. The changes caused by increase of brain pressure are: enlargement of the cranium, deepening of the impressiones digitatæ, widening of the sutures, superficial ulcerations of the sella turcica, and general widening of the venous canals of the cranium.

Fig. 12 (above). Traumatic defect (meningocele spuria traumatica). (See p. 194.)
Fig. 13 (below). High intracranial pressure.

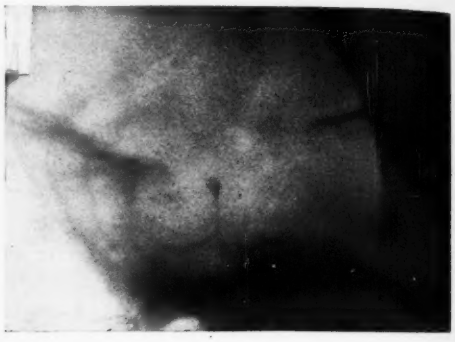


Fig. 14. Pituitary tumor. (See p. 197.)

In the following paragraphs I will enumerate some of the more frequent types:

I. Hydrocephalus associated with tumors of the posterior cranial fossa or as the sequel of meningitic adhesions at the base of the brain (hydrocephalus internus occlusus) or at its convexity (hydrocephalus communicans). The cranium is spherical in shape, enlarged, the walls are thin, the impressiones digitatæ are deepened, the sutures are widened, and the sella turcica, owing to the pressure of the third ventricle, is hollowed out. (Fig. 13.)

II. Unilateral hydrocephalus and tumors of the cerebrum. The side of the cranium within which the hydrocephalus or the tumor is localized may be enlarged and present thin walls and deepening of the impressiones digitatæ. Frequently, however, the portion of the cranium that corresponds to the tumor is normal or there may be local thickening; namely, in the presence of meningiomas lying near the surface (endotheliomas of the meninges), whereas the oppo-

site side, owing to hydrocephalic widening of the lateral ventricle, appears thinner than normal.

III. Tumors of the base of the brain (tumors of the pituitary body, tumors of the auditory nerve, aneurysms of the basal arteries, meningiomas). They cause localized superficial ulcerations, less frequently localized hyperostosis of that portion of the base of the cranium to which they are directly attached. For instance, in tumors of the auditory nerve one observes not infrequently enlargement of the meatus acusticus internus or of the pyramidal eminence, and in tumors of the hypophysis and in basal aneurysms enlargement of the sella turcica. (Fig. 14.) In addition, the signs of a general increase of brain pressure of greater or less degree are usually marked. If the tumor is calcified, its presence is revealed by cloudy, spotted lime shadows with indistinct outlines. For aneurysms, the calcareous platelets or scales lodged in their walls are characteristic.

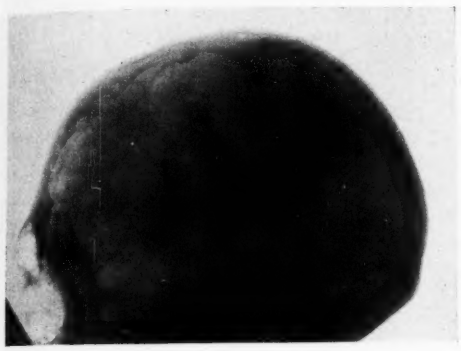


Fig. 15. Oxycephaly.

IV. Turricephalus. The peculiar shape of the skull, the predominance of the vertical diameter as compared with the sagittal diameter of the cranial dome, the abrupt rise of the forehead, the projection of the bregma and the temporal region, the thinness of the cranial wall, the marked deepening of the impressiones digitatæ, the deformation of the base of the cranium, the sagging of the middle cranial fossa, the obliteration of the cranial sutures and the absence of the enlargement of the sella turcica —all these symptoms taken together establish the diagnosis of turricephalus.

Fig. 16 (above). Digital impressions (migraine). (See p. 198.)

Fig. 17 (below). Calcified carotid artery. (See p. 199.)

V. Idiopathic migraine. In cases of familial true migraine one finds not infrequently deepening of the impressiones digitatæ, a sign which points to a disproportion between the size of the cranium and the brain, evidently caused by the abnormal size of the brain. Also in symptomatic mi-

graine, which often occurs in persons with mild tuberculosis as an expression of a tuberculotoxic meningitis and which can be favorably influenced with tuberculin injections, the roentgenogram shows signs of a slight increase of brain pressure (Fig. 16).

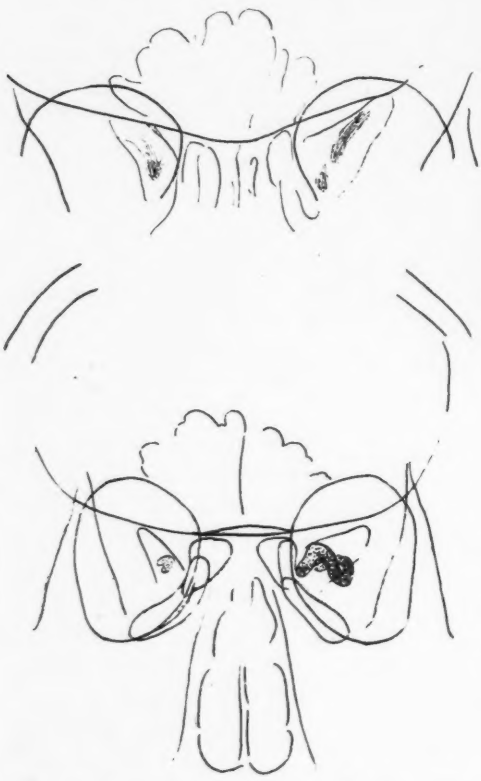


Fig. 18 (above). Calcified carotid artery. (See p. 199.)

Fig. 19 (below). Calcified tortuous carotid artery. (See p. 199.)

At this point, I wish to say a word in regard to the diagnostic importance of the accentuated impressiones digitatæ. Some authors hold that they have no diagnostic significance and the assertion is made that accentuated impressiones digitatæ are frequently found in healthy persons; in other words, that they constitute merely an individual variation. In opposition to such a conception, I must declare emphatically that accentuated impressiones digitatæ of the cranial dome in man are always to be regarded as a symptom of a disproportion between the brain and the capacity of the cranium, even though clinical symptoms do not exist at the time of the examination and did not exist

Fig. 20. Osteoma of the ethmoid. (See p. 200.)

previously. Symptoms of disproportion do not usually appear until brought out by definite causes; for instance, in acute fevers, mental or physical over-exertion, or in cranial injuries. Under these circumstances, sudden death frequently occurs, as the cause of which the necropsy reveals no anatomic changes other than the accentuated impressiones digitatæ.

I will add a few words on positive roentgen-ray findings in connection with localized headache. It will be recalled that patients frequently refer to a strictly circumscribed spot of the cranium as the site of an obstinate pain, usually described as piercing. Such localized pains occur sometimes in brain tumors and are regarded as an important local diagnostic symptom, especially if the roentgenologic examination reveals an abrasion or thickening of the cranial wall at a corresponding site. Often the roentgenogram shows deepened pacchionic depressions at the spot designated by the patient as the seat of an obstinate pain. In other cases, the patient states that the pain is the most severe along a definite line. The roentgeno-

Fig. 21. Carcinoma of the sphenoid sinus. (See p. 200.)

gram sometimes shows, then, that, corresponding to the line stated, there is a widened suture or a broad venous canal which penetrates the bone deeply. It should be mentioned that certain places on the cranium may be normally very thin. Such places are found, namely, in the region of the portions of the frontal bone that lie near the median line, and also at the junction of the dome and the base of the cranium.

In connection with the discussion of headache associated with intracranial affections, I will mention briefly the headache caused by affections of the blood vessels of the brain. It will be recalled that headache is one of the earliest and most constant symptoms of arteriosclerosis of the brain arteries. In fact, it is not such a rare thing to be able to demonstrate through roentgenograms that the larger basal arteries are calcified in elderly persons who present clinical manifestations of cerebral arteriosclerosis. The arteries affected are usually: arteria basilaris, carotis interna and cerebri media. (Figs. 17, 18 and 19.)

The last group of frequent positive roentgen-ray findings in headache is represented by the affections of the air spaces. Acute inflammatory affections of the accessory sinuses are revealed in the roentgenogram by shadows in the normally light area of the affected sinus. However, there must be marked inflammation of the mucous membrane or considerable quantities of secretion to produce a distinct shadow. Diagnostic difficulties arise, however, in case the sinuses of the two sides show a difference in size, or if the sinuses of both sides are affected. More easily recognized are the chronic inflammations of the accessory sinuses of the nose. They may be detected not merely by the shadows but also by the indistinct outlines, the normally compact marginal layer of the sinus disappearing. It is characteristic of the enlargements of the accessory sinuses caused by retention of secretions (a mycocele or pyocele) that they change not only the size but also the shape of the sinus and cause the adjacent bones either to bulge out or to become thinner. As indicative of

a mycocele or pyocele, one finds sometimes a lighter area and sometimes a darker area than in the region of the normal accessory sinuses. Occasionally one notes in the roentgenogram evidence of tumors of the accessory sinuses—most frequently, osteomas (Fig. 20), but also malignant neoplasms, which, after occupying the space of the sinus, attack the surrounding bony parts. (Fig. 21.) The roentgenograms secured in the presence of malignant tumors (carcinomas of the accessory sinuses, sarcomas of the pharynx or of the eustachian tube) are characterized by shadows in the affected accessory sinuses and by a lighter appearance of the bone shadows in the vicinity of the accessory sinuses. Through pressure on the nerve trunks that pass through the bone canals, tumors of the accessory sinuses cause severe neuralgias.

SUMMARY

The purpose of this article is to demonstrate to the general practitioner and likewise to the specialist—more particularly, the neurologist, the ophthalmologist, the otologist and the rhinologist—who almost every day are called upon to advise patients with respect to headaches—how much and how important information can be derived from roentgenograms in the diagnosis and treatment of the individual case. I need to refer only to the roentgen-ray findings in syphilis and in injuries. But I trust that the article may be of some interest to the roentgenologist as well, since it contains what, as far as I am informed, is the first complete enumeration of the affections causing headache, in so far as they come within the scope of roentgenologic examination.

RADIOGRAPHIC DIAGNOSIS OF GALL-BLADDER DISEASE

By CARL S. OAKMAN, M.A., M.D., Muncie, Indiana

THE advent of cholecystography by the means of soluble radiopaque substances, according to the method developed by Graham, of St. Louis, and his associates, has largely overshadowed the roentgen diagnosis of gall-bladder disease as formerly practised. In August, 1925, (1) I published an article embodying the result of investigations carried out personally with the Graham test; the article, however, did not include the result of a coincident inquiry into and a summary of the older methods. It would seem to be appropriate at this time to present this review, for purposes of comparing the old and the new procedures.

I. HISTORICAL

From the time when X-rays were first discovered in 1895, there were constant attempts to use them in the diagnosis of gallstones. There was a growing recognition that gallstones occurred frequently and were the cause of a long train of dyspeptic symptoms, and it was a disappointment to the medical profession when it was again and again proven that X-rays failed to reveal them. Carl Beck, (2) of New York, was the first to succeed in registering biliary calculi on radiographic plates (1899), with publication of results, and his article stimulated anew the efforts of roentgenologists in this direction. It was early realized that the chemical composition of calculi determined the relative ease of their portrayal on plates, and for many years it was considered impossible to register shadows of any calculi except those containing lime. In a period of thirteen years following Beck's paper, there were scattering reports by others who registered gallstone shadows, but they were so few that the aid of the roentgenologist was seldom sought by clinical men. Moreover, the possibility of visualizing a diseased gall bladder containing no stones, or of inferring its existence by indirect evidence was not conceived.

In 1913, however, Cole (3) and Case, (4) in independent articles, gave a great impetus to the subject by reporting an unusual number of correct diagnoses, not only of gallstones but of cholecystitis, utilizing the data gained by study of the behavior of the stomach and intestines when outlined by the opaque meal. Pfahler (5) and George, (6) in 1914, confirmed the value of this new method, and in the following ten years nothing radically new was added to our knowledge. It soon became evident that any great degree of success in diagnosing gall-bladder disease by X-ray was dependent upon exceptional skill, care and perseverance, and few roentgenologists obtained results equal to the pioneers above mentioned. Consequently the profession at large, being remote from such men, were but indifferently served by X-ray in these cases and were not convinced of its helpfulness. Occasionally an outstanding figure like Kirklin, Carman, or Knox demonstrated the real value that could be delivered by proper technic, but for the most part the diagnosis of gall-bladder pathology was helpful in that small minority of cases when absolute shadows of calculi were demonstrable or when the indirect evidence was undeniable. In all other cases the roentgenologist could at most say that he saw no positive indication of disease, but he could not exclude it. The number of such cases was discouraging to all concerned.

II. TECHNIC

At this point it is appropriate to recapitulate the method by which, up to 1924, a positive diagnosis of gall-bladder disease was usually made. It will quickly be seen that

there were many variations, dependent upon the preference of the individual, especially with regard to technic.

First, as to preparation of the patient. All were agreed that it is desirable that the stomach, duodenum and gall bladder should be subject to the least possible intrinsic or extrinsic motion during the X-ray examination. To assure this, numerous different means were used prior to the examination. Carman (7) directed castor oil or a saline, followed by fasting. George and Leonard (8) advised only cleansing enemata and an empty stomach. Knox (9) recommended purgation far enough in advance to allow the bowels twelve hours to come to rest, and an empty stomach, but no fasting. Kirklin (10) gave compound licorice powder each night for two or three periods, and twelve-hour fasting. Bissell (11) stipulated no preparation except twelve-hour fasting. O'Brien (12) prescribed effervescing salines, enemata and fasting.

From the variation in detail, it is surmised that no one method brings about an unfailing quietude of the mobile and motile viscera involved. Each man will work out the procedure which succeeds best in the circumstances attending his own practice.

With regard to technic, the details are fundamentally the same as for all other good radiographic work; the gall bladder must be as close to the film as possible; the patient must be absolutely still; the exposure factors must be such as to produce the maximum detail of soft tissues.

Beck early placed the patient prone, with pillows under symphysis and under clavicles, bending the trunk slightly to the left and raising the left side. Pfahler (5) sometimes elevated the film to make it press into the abdomen and thus closer approximate the gall bladder. Cole developed a similar idea with a special plate holder to conform to the anatomy. Knox claimed that it was sometimes useful to take films in the supine position, and also insisted upon the routine addition of lateral exposures.

The stillness of the patient is the hardest condition to meet. Careful instruction and rehearsing must be given to insure immobility of the entire body and proper holding of the breath. Some insist upon holding the breath at full inspiration, some at expiration, and some prefer holding at some point between in- and expiration to minimize phrenic spasm. Roberts (13) says: "The stone with a calcium layer one-thirty-second of an inch in thickness casts a perfect and unmistakable ring shadow if it is perfectly stationary, but will be half as dense if it moves one-thirty-second of an inch." Immobilization of the diaphragm to prevent an excursion of one-thirty-second of an inch is difficult to attain, and failure often means a missed diagnosis.

Exposure factors vary in detail among roentgenologists, but in general it is agreed that all secondary radiation must be reduced to a minimum; speed is desirable; detail is essential; penetration enough is required to just get through the body. All these factors cannot be ideally satisfied at once, and therefore one skimps some to attain others. It is necessary to take several, perhaps many, films to register existing pathology. It is undoubtedly in the actual technical details that skill, care and patience have spelled extraordinary success for a few in this particular field. A score of exposures and two or three hours of time are often spent on one patient to shadow forth the elusive gallstone, or the viscus itself. Knox (9) used to wait an hour after giving the opaque meal to record the behavior of the duodenal bulb alone, and this was, of course, subsequent to the gall-bladder films.

For the most part, experience alone confers the kind of judgment that decides correctly the exposure factors that shall apply. The item of physical build and body weight is one that has constantly to be reckoned

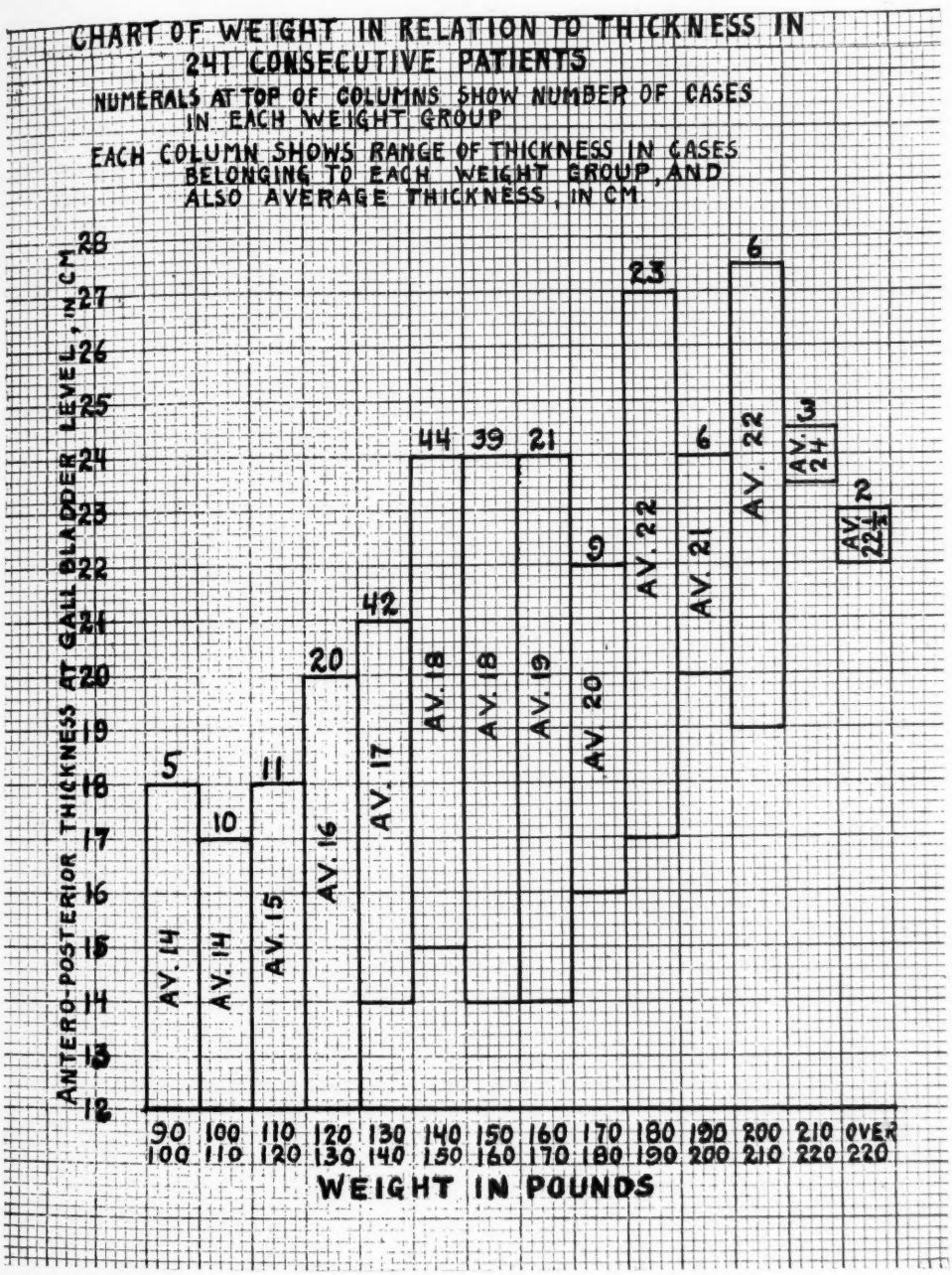


Fig. 1

with in estimating proper penetration, milliampere seconds, distance and orientation. Caliper measurement is more reliable than weight. In this connection the writer calipered 241 consecutive cases and recorded them, with body weights, as shown in the

accompanying graph (Fig. 1). Measurement was taken in the erect position from a point just below the right costal margin, two and a half inches from the midline, to a point on the back at the same horizontal level, same distance from the midline. This measurement records the relative thickness of tissues through which the rays must pass. It is manifestly a safer guide than body weight.

Fluoroscopic examination for gall-bladder pathology is helpful in localizing tender points and in orienting the pylorus and duodenum, and observing their function and motility when outlined with the opaque meal. Serial films supplementing the gall-bladder films are indispensable for recording the fluoroscopic findings.

III. DIAGNOSIS, DIRECT

In reading films of gall-bladder disease, it was early recognized that here again the greatest care and perseverance were required. Casual inspection will never reveal the vague half-hidden shadows that indicate pathology of this organ. Assuming that intensifying screens, films, and dark room technic have been of the highest quality, the films must still be guarded against marring or finger-prints, and must be scrutinized at all angles, from far and near, under properly tempered light. Sometimes multiple films are exposed in one cassette, and then superimposed to intensify detail.

Gallstones that are of a density similar to body tissues are sometimes detected only after considerable study, if at all. Single stones a half-centimeter or more in diameter may register a crescentic or a straight thin shadow only when caught at just the right angle at time of exposure. Others may cast a negative shadow, this point having first been most strikingly developed by George, (6) in 1914. The shadow values given by stones of different composition interested X-ray observers from the beginning. Bevan, discussing Case's paper in 1913, said he had found in 1898 that cholesterin stones placed in a beef liver gave no shadow. Later experimenters discovered their capacity under certain conditions for casting negative shadows. The writer has made numerous observations along this line. For example, a freshly removed gall bladder containing a single round stone 1 cm. in diameter, and slightly heavier than water, was rayed so as to show clearly all details, including a pinpoint center of greater density in the stone. Placed at the bottom of a four-inch water phantom, simulating roughly the environment *in vivo*, the stone could be shown only as a negative shadow, and then only with certain exposure factors. If this difficulty obtains through a homogeneous medium like water, how much more difficult to register through all the confusing shadows of varying density and outline cast by human tissues.

Another gall bladder containing two facetted stones of 1 cm. and ½ cm. diameter was rayed at the bottom of a four-inch water phantom, and the stones could be visualized only within a narrow range of exposure factors. Under optimum conditions they revealed a very faint thin ring shadow signifying a delicate lime deposit. The gall bladder itself cast no shadow whatever. With the gall bladder placed two inches above the bottom of the water phantom there was a slight magnification of the gallstone shadows and a lessened definition.

Two large stones, 3 cm. in diameter, roughly quadrilateral in shape, were rayed under optimum conditions; one showed considerable lime crust, the other almost none. They were then rayed at different levels in a water phantom with different exposure factors. A point was found where the lime-free stone cast a positive shadow, and another point where the lime-free stone was not visible, either as a negative or a positive shadow. These same stones, placed under a patient in the prone position, registered

plainly the difference in their character, but placed on the patient's back, their shadows were of a quality indistinguishable from each other.

Experiments of this sort explain the difficulty in visualizing gallstones under actual conditions of practice. Aside from gallstones, the gall bladder may be silhouetted if distended, or thickened, or filled with inspissated secretion, and the consensus of opinion is that, when so seen, there is pathology present.

Roberts, (13) however, performed experiments from which he asserts that pathologic bile casts no denser shadow than normal bile or water, but that a much thickened gall bladder casts a denser shadow.

It should be mentioned that various procedures have been tried to increase the possibility of obtaining shadows of the gall bladder, such as inflation of the colon by rectum, inflation of the stomach by effervescent mixtures, and even by pneumoperitoneum.

IV. DIAGNOSIS, INDIRECT

Valuable diagnostic signs,—so-called indirect signs,—are obtained during the opaque meal examination. In fact, many men used to depend more on this than on direct evidence. Kallen, (14) in 1922, recapitulated twenty-one signs and discussed their significance, but usually a half-dozen or so are regarded as important. The emphasis on the various signs varies with different men. For instance, Carman (7) listed eight points, as follows:

1. Gastric spasm.
2. Six-hour residue in stomach or duodenum.
3. Fixation of pyloric end of stomach, duodenum or hepatic flexure.
4. Drawing of stomach to right, or displacement to left.
5. Increased gastric peristalsis.
6. Demonstration of Riedel's lobe of liver.
7. Localization of a tender point over gall-bladder area.
8. Demonstration of a normal stomach and duodenum, thus excluding them as cause of symptoms.

Kirklin (10) gives the following six points:

1. Pressure on duodenum or antrum.
2. Displacement of jejunum or colon.
3. Adhesion deformities of bulb.
4. Pulling of second part of duodenum to right.
5. Hepato-fixation of stomach.
6. Emptying time of stomach shortened.

George and Leonard (8) give the following:

1. Pressure on duodenum or antrum.
2. Secondary changes due to adhesions.
3. Fixation of organs.
4. Spastic changes in stomach.
5. Filling of ampulla of Vater.

Analyzing the points regarded as important by the authorities above mentioned, there is a total of sixteen different points, allowing for differences in diction. There are only three points included by all:

1. Pulling of pyloric end of stomach to right.
2. Fixation of hepatic flexure.
3. Pressure deformity of bulb or antrum.

V. ANALYSIS OF CASES FOR INDIRECT SIGNS

In order to determine the relative importance of X-ray criteria of gall-bladder disease, the writer analyzed the fluoroscopic reports and the films of seventy cases that had subsequently come to operation for gall-bladder disease. These cases represented the total number that had been both operated on and radiographed during a period of thirty-four months ending May 1, 1925, at the University Hospital in Ann Arbor.

In this group there were 54 women, average age 42 plus, average weight 143, and 16

men, average age 41 plus, and average weight 158.

There was a pathological report in 64 cases.

There were 65 cases with a pre-operative clinical diagnosis of gall-bladder disease, including 25 clinical diagnoses of gallstones. The remaining five cases were diagnosed clinically, one as abdominal abscess, one as duodenal diverticulum, one as retroperitoneal cancer, one as duodenal ulcer and one was not recorded.

There were six mistakes in pre-operative diagnosis, as follows:

Pre-operative diagnosis	*Condition found*
1.—Retroperitoneal cancer.	Cancer of gall bladder and liver.
2.—Cholecystitis.	Obstruction of small bowel.
3.—Cholecystitis.	No pathology found.
4.—Duodenal diverticulum.	Gall-bladder disease.
5.—Duodenal ulcer.	Gall-bladder disease.
6.—Cholecystitis.	Appendicitis.

There were two cases doubtful as to correctness of pre-operative diagnosis: one was diagnosed as empyema of gall bladder, and, upon opening the abdomen, an extensive walled-off abscess of uncertain origin was found. In one, the pre-operative diagnosis was not recorded but operation showed gall-bladder disease.

The 25 cases diagnosed pre-operatively as gallstones were all verified at operation, but the entire series showed 39 cases where gallstones were found by the surgeon, proving the frequency of occurrence without arousing suspicion. There were three cases where the operative records made no mention of gallstones, but where the pathologist reported them. There were also three other cases where the operative record mentions a solitary stone palpated in the viscus, while the pathologist reported multiple smaller stones. It is, of course, understood in all these cases that the viscus is tied off and removed *in toto*, and submitted to the pathologist before being opened. However, there are numerous cases on record where surgeons have failed to recognize multiple stones on palpation of the organ, because of thickened walls, softness of stones, or inspissated bile.

The X-ray records in the 70 cases showed a total of 37 diagnoses of gall-bladder disease, including six diagnoses of gallstones. These positive diagnoses were confirmed in 35 cases, and in the other two the gall bladder was reported normal at operation but the coincident X-ray diagnosis of appendicitis was verified. The X-ray report was "negative" in 17, indeterminate in three and the remainder scattered as follows: In seven reported as appendicitis, the appendix was diseased, but, in addition, a pathologic gall bladder was found, including calculi in six cases; there was one of each of the following diagnoses—cancer of pylorus, gastric ulcer, duodenal ulcer, each being disproved at operation; there was one diagnosis of duodenal diverticulum, which proved to be due to gall-bladder disease, one of perirenal abscess which at operation was found to be an abscess of unknown origin, presenting in right upper quadrant, and one of obstruction of the intestine, which was confirmed. Eliminating from the entire series the 17 negative X-ray diagnoses and the seven appendicitis diagnoses, there remain 46 positive X-ray diagnoses of one condition or another, 37 (80 per cent) of which were correct.

This again confirms what has so often been said, namely, that a positive X-ray diagnosis in cholecystic disease is quite reliable, but a negative finding by no means excludes it. Stating the proposition in another way, the series shows that gall-bladder pathology existed in 66 cases, of which 35, or 53 per cent, were detected by X-ray.

In assembling the X-ray data, the occurrence of the principal signs was checked and Table I gives a summary. It should be remarked that the X-ray examinations were

performed by numerous individuals, and their methods of recording observations varied, according to circumstances which were more or less uncontrolled or beyond control. The final adoption of a uniform printed blank tended to eliminate these variations. Practically every case in the series received both a fluoroscopic examination and film exposures, the great majority by the "serial film" method; the routine opaque meal was barium sulphate in buttermilk, preceded by a small amount of a heavy barium suspension in acacia solution, for study of the esophagus. Gall-bladder detail films were made before the meal in 48 cases. In the remainder, the gall-bladder films were either not made or were technically unsatisfactory.

The series was reviewed by studying the X-ray films and fluoroscopic reports and setting down the findings before consulting the surgical records. In only one instance did the latter lead to the subsequent detection of calculi on the films. The analysis therefore represents a composite of observations,—those on the fluoroscopic examinations are necessarily the opinions of numerous men, but those on the films are uniformly the writer's and occasionally differ in detail and in diagnosis.

Column I analyzes the 70 cases, regardless of diagnosis.

Column II analyzes the 37 cases reported as gall-bladder pathology by X-ray examination.

Column III analyzes the 24 cases where gall bladder was not detected by X-ray.

Column IV analyzes the 44 cases of pathologically severe disease.

TABLE I

	Total series 70	Gall bladder by X-ray 37	Negative by X-ray 24	Severe cases 44
Tenderness in right upper quadrant or epigastrium Tenderness not mentioned—38	14	7	7	6
Abnormal position of pylorus *(b)*	15	8	6*(a)*	11
Pressure on antrum or cap	27*(c)*	13	10	13
Tubular or spastic antrum *(d)*	37	19	17	25
Gastric hyperperistalsis *(e)*	21	10	10	12
Displaced bulb *(f)*	42	23	19	26
Small or spastic bulb or none visible	26	12	14	20
Ragged or deformed bulb, without pressure *(g)* Normal bulb—10	28	12	16	18
Abnormal rate of discharge from bulb *(h)* Rate of discharge not recorded—41	15	8	6	9
Gastric retention, from slight up to 50 per cent *(i)*	14	5	9	12
Second part of duodenum displaced *(j)*	27	10	16	19
Irregular right leaf of diaphragm *(k)* Diaphragm not mentioned—15	12	6	6	5
Fixed colon close to gall bladder Colon not mentioned or seen—28	24	10	14	15
Jejunum fixed in right upper quadrant	2	0	2	1
Dilated duodenum, distal to bulb	5	2	3	2

(a) Discrepancy will occasionally be noted in that the total of the second and third columns does not equal the first column. This is explained by the fact that Columns II and III include a total of only 61 cases comprising X-ray diagnoses positive for gall-bladder disease, and X-ray diagnoses negative for gall-bladder disease.

(b) By far the most common displacement was hepato-fixation.

(c) Pressure was a pronounced smooth and constant deformity of the bulb in nine cases and inconstant or ragged in eight.

(d) This designation is for those cases where the antrum never fills out with a normal bi-convex or globular form.

(e) "Hyperperistalsis" is applied to those cases where three or more deep waves are visible at once.

(f) By far the commonest displacement of bulb was to the left of its normal place with relation to the pylorus (30 cases). In 12 cases it was pulled down to the right in a more or less horizontal position.

(g) There were so many instances of ragged and fantastic bulbs, aside from pressure deformities, that it became interesting to record them. They are doubtless due to adhesions or spasm. In this category were three cases of greatly enlarged bulbs.

(h) The rate of discharge was abnormally rapid in 13 cases and noticeably delayed in two. Otherwise the duodenal "lag" (three) was not recorded.

(i) In nine cases of gastric retention there was spasm of the antral end or a tubular conformation.

(j) The displacement of second part of duodenum was "up" or to the right, resulting in an oblique downward course to right or left.

(k) The diaphragm in these cases was observed, usually fluoroscopically, to be wavy or angular in outline, or high, or limited in excursion, or paradoxical.

The filling of the ampulla of Vater and the occurrence of Riedel's lobe were never observed in this series, though the former has been seen in cases not coming to operation.

Numerically, the most important signs in this table are *displaced bulb, tubular or spastic antrum, pressure on antrum or cap, other changes in size or contour of cap, displacement of second part of duodenum, fixation of colon,* and *gastric hyperstalsis.* Good authorities can be found who lay stress on one or another of all these signs, but authorities unite especially on *displaced bulb, pressure deformities* and *fixation of colon.* While displacement of the pylorus is regarded as important, yet in this series it is seen less often.

The question occurs, Does the degree of the pathologic involvement reflect proportionately in X-ray signs? We may justifiably assume that old chronic cases of cholecystitis, most cases of calculi, and all cases of purulent contents denote considerable pathologic change. Therefore, those cases were assembled which showed by operative or pathological examination one or several of the following conditions: thickening, fibrosis, large or numerous stones in the bladder, especially if containing much lime, stone in cystic or common duct, gangrene, ulceration, purulent or inspissated contents. There were 44 such cases with X-ray signs, distributed as in Column IV of the table. It is seen that the only signs that are preponderant (compare Col. I) are: *abnormal position of pylorus* (mostly hepato-fixation), *tubular or spastic antrum, small or spastic bulb,* and *gastric retention.* The other signs seem to occur about as often in less serious cases as they do in more serious ones.

Another question arises, *viz.:* What X-ray signs were present in the cases where the gall bladder was practically not diseased at all? There were three such cases. The first showed a tubular antrum, a smooth concavity on lesser curvature of bulb, which was somewhat pulled down to the right, and in high hepatic flexure, full of gas. A cholecystostomy was done. The second showed pressure on lesser curvature of antrum and of bulb; the bulb was elongated and somewhat drawn up. The gall bladder was removed, with no description of adhesions, and the pathologist reported a normal viscus. The third showed hyperperistalsis, a large fantastic shaped bulb, a hooked-up second part of the duodenum, somewhat dilated; at operation the surgeon palpated the gall bladder and declared it normal, and then did only an appendectomy.

While it might have been warranted to make an X-ray report of "indirect signs consistent with gall-bladder disease" in numerous cases that were reported as "negative," yet in some of them the evidence was quite negligible. For example, one case showed only tenderness and a bulb slightly to the left of the pylorus which was in normal position; this case proved to have a gall bladder with numerous adhesions full of pigment calculi and pus. Another showed only a dubious hyperperistalsis and an irregular right leaf of the diaphragm, but at operation a chronic thickened gall bladder was found, adherent to the duodenum. Another showed tenderness, a tubular antrum and slight compression of the bulb from above, but no real pressure defect. This case at operation revealed atrophic cholecystitis, with adhesions to duodenum and colon. The solitary case of carcinoma of gall bladder had a roentgen examination that was recorded as negative with respect to gall-bladder signs, but the films were missing and so could not be reviewed.

The cases that were actually reported as definite or suggestive gall-bladder pathology showed on review an average of 4.2 signs. The cases that were not reported as gall-bladder pathology, but where it was actually proved to exist, showed on review an average of 5 signs. This anomaly can most-

ly be explained by the varying factors that constantly influenced the examinations, such as changing personnel, changing equipment, altered routine, inability of certain patients to co-operate, etc. It is notable that 13 cases showing three or *less* indirect signs were reported as gall-bladder disease. If the criteria that were applied to the positive diagnoses of gall-bladder disease could have been similarly applied to the other cases, 23 of them would have been correctly diagnosed; this would have brought the total of gall-bladder diagnoses up to 58, out of 66, or 81.7 per cent, that proved to be gall-bladder disease.

In the total series of 70, the signs averaged 4.5 per case. The grouping of signs is shown in Table II below.

TABLE II

Cases showing 1 sign	4
Cases showing 2 signs	5
Cases showing 3 signs	12
Cases showing 4 signs	10
Cases showing 5 signs	20
Cases showing 6 signs	11
Cases showing 7 signs	3
Cases showing 8 signs	1
Cases showing 9 signs	2
Cases showing 10 signs	2

SUMMARY

While it is unsafe to deduce any generalities from such a small series of cases, yet it is permissible to summarize with reservations.

As a result of the analysis of the indirect signs in these 70 cases, the following conclusions are drawn:

I. There is no one indirect sign that occurs in all cases of gall-bladder disease.

II. There is no one indirect sign that is surely pathognomonic of gall-bladder disease.

III. The major important indirect signs are the following:
   1. Hepato-fixation of antrum.
   2. Displacement of bulb to left or downward to right.
   3. Definite pressure deformity of antrum or bulb.
   4. Distortion of bulb by adhesions or spasm.
   5. Fixation of colon close to gall bladder.
   6. Tenderness located in gall-bladder area during fluoroscopic examination.
   7. Displacement of second part of duodenum to right.

These may be condensed as follows:
   1. Changes caused by adhesions (1, 2, 4, 5 above).
   2. Pressure deformities.
   3. Spastic changes.
   4. Tenderness.

IV. The greater the number of signs in a case, the greater likelihood of gall-bladder disease.

V. In the presence of certain of these signs, the probability of gall-bladder disease increases in proportion to the ability to rule out intrinsic disease of stomach, duodenum, pancreas and appendix.

VI. The estimation of the value of these signs is enhanced by conference with the clinician in each case.

With regard to the direct signs by X-ray, there were separate gall-bladder detail films in 48 cases, of which ten showed a definite or suggestive shadow of the gall bladder. When thus seen, the viscus is recorded as pathologic, in accordance with the prevailing opinion. Review of the films revealed gallstones in nine cases out of 39 where they were later proved present,—a percentage of 23. This percentage can, of course, be increased under circumstances where much time, infinite care and perseverance are devoted, but such is not possible in a busy hospital clinic; hence the great importance of a systematic and uniform meth-

od of observation and interpretation of the indirect signs, which requires little time and moderate care.

However, if the search for both direct and indirect signs has ended fruitlessly, the diagnosis of gall-bladder disease still cannot be excluded, and this is likely to occur in at least one case in five, or 20 per cent.

It is quite apparent that the barium meal will present many indirect signs of gall-bladder pathology, no one of which is pathognomonic, and it is only by the experienced roentgenologist that these signs can be safely interpreted. This unreliability is largely due to the fact that many of these signs may be caused by pathology existing elsewhere than in the gall bladder. In the routine barium meal examination the roentgenologist will continue to notice these signs, without adequately explaining their significance, unless the data gathered from the Graham test are correlated with those gathered from the barium meal. The pathologic gall bladder causes many organic and functional abnormalities in the region around the gastric outlet; the Graham test now allows us to state quite definitely in a given case whether or not these abnormalities are associated with a pathologic gall bladder. In the course of time the accumulated knowledge thus gained ought to make the barium meal of greater diagnostic value than ever.

REFERENCES IN TEXT

1. Oakman, C. S.: Am. Jour. Roentgenol. and Rad. Ther., 1925, XIV, 105-110.
2. Beck, Carl: N. Y. St. Med. Jour., 1900, LXXI, 73-77.
3. Cole, L. G.: Surg., Gynec. and Obst., 1914, XVIII, 218-227.
4. Case, J. T.: Jour. Am. Med. Assn., 1913, LXI, 920-924.
5. Pfahler, G. E.: Jour. Am. Med. Assn., 1914, LXII, 1304-1306.
6. George, A. W., and Gerber, I.: Boston Med. and Surg. Jour., 1914, CLXX, 680.
7. Carman, R. D.: Roentgen Diagnosis in Diseases of the Alimentary Canal, Chap. XVIII, 414.
8. George, A. W., and Leonard, R. D.: The Pathological Gall Bladder. Hoeber, 1922.
9. Knox, R.: Acta Radiologica, 1924, VIII, 25.
10. Kirklin, B. R.: Am. Jour. Roentgenol. and Rad. Ther., 1922, IX, 713-722.
11. Bissell, F. S.: Minn. Med., 1923, VI, 681-683.
12. O'Brien, F. W.: Boston Med. and Surg. Jour., 1916, CLXXIV, 309.
13. Roberts, D.: Jour. Am. Med. Assn., 1924, LXXV, 1534.
14. Kallen, L.: Northwest Med., 1922, XXI, 172-178.

OTHER REFERENCES CONSULTED

Teschendorf, W.: Fortschr. a. d. Geb. d. Röntgenstrahlen, 1923, XXXI, Kongressheft, 54-56.
Arens, R. A.: Jour. Radiol., 1923, IV, 274.
George, A. W.: Arch. Radiol. and Electrotherapy, 1923-4, XXVIII, 33-47.
Eisler, F.: Wien. klin. Wchnschr., 1923, XXXVI, 521.
Thompson-Walker, Sir John, and Knox, R.: Am. Jour. Roentgenol. and Rad. Ther., Sept., 1923.
Carter, L. J.: Radiology, Sept., 1924.
Rubaschow, S.: Fortschr. a. d. Geb. d. Röntgenstrahlen, 1914, XXI, 533-536.
Cole, L. G., and George, A. W.: Boston Med. and Surg. Jour., 1915, CLXXII, 326-330.
Caldwell, E. W.: Am. Jour. Roentgenol., 1915, II, 816-819.
Case, J. T.: Arch. Roentgen Ray, 1913, XVIII, 135-139.
Palmer, Dorwin: Am. Jour. Roentgenol. and Rad. Ther., Nov., 1923, p. 901.
Arens, R. A.: Jour. Radiol., 1922, III.
White, Franklin W.: Med. Clin. N. A., 1923, VII, No. 3, 909.
Shoup, J.: Am. Jour. Roentgenol., 1917, IV, 580.
Vanderhoof, D.: Jour. Am. Med. Assn., LXIX, 510.
Knox, R.: Arch. Radiol. and Electrotherapy, 1919, 24:37, and each month following to Oct., inclusive.
Crouse, H.: Texas St. Med. Jour., 1920, XV, 394.
Knox, R.: Brit. Med. Jour., Aug., 1921, p. 280.
Rohde, C.: Arch. f. klin. Chir., 1921, CXV, 727.
Pfahler, G. E.: Fortschr. a. d. Geb. d. Röntgenstrahlen, 1911, XVI, H. 5, S. 335.
Pfahler, G. E.: Jour. Am. Med. Assn., 1911, LVI, 1777-1779.
Holland, C. Thurstan: Arch. Roentgen Ray, 1913, p. 374.
Kirklin, B. R.: Ind. St. Med. Jour., 1921, XIV, 1.
Kirklin, B. R.: Jour. Radiol., May, 1921.
Weiss, S.: N. Y. St. Med. Jour., 1921, CXIV, 297.
Schmidt, H.: Arch. f. klin. Chir., 1921, CXVII, 425.
Rieder, H.: Fortschr. a. d. Geb. d. Röntgenstrahlen, 1922, XXVIII, 512.
Keller: Bull. et mém. Soc. de Radiol. med. de France, 1912, X, 127.
Nichols, B. H.: Surg. Clin. N. A., 1924, 4-4, p. 921.
Holland, C. T.: Liverpool Med.-Chir. Jour., July, 1914, p. 308.
Pfahler, G. E.: Jour. Radiol., 1915, I, 774.
Oram: Arch. Roentgen Ray, 1915, XIX, 438.
Macleod: Arch. Radiol. and Electrotherapy, 1916, XXI, 117.
Burnham, M. P.: Am. Jour. Roentgenol. and Rad. Ther., 1923, X, 105.

A METHOD FOR THE STUDY OF SCATTERED AND SECONDARY RADIATION IN X-RAY AND RADIUM LABORATORIES

By EDITH H. QUIMBY, M.A.
Biophysical Laboratory, Memorial Hospital, New York City

THE question of the exposure to radiation of workers with X-rays or radium is generally recognized as very important. It is known that the effect of radiation is cumulative, to a certain extent. The amount received at any given time may be small, but the more or less continuous exposure to such small quantities may presumably in time produce a very serious effect. This radiation does not, in general, come mainly from the primary source,—the X-ray tube or radium applicator. It is the scattered and secondary radiation from walls, floors, and other solid objects which must be guarded against, because it is less obvious, and from such radiation it is harder to shield oneself.

It would be very desirable to know (1) how much radiation an individual can receive without harmful effects, and (2) how much any given individual is receiving. In order to ascertain these points, it is necessary to devise a method of measuring quantitatively the amount of radiation being received by any worker. When this is done, the first question can be answered by a study of the condition of many X-ray and radium technicians who have been exposed for a considerable time.

The usual method of investigating the scattered and secondary radiation in a given place is to expose dental films for some days or weeks. If a film shows considerable darkening in a short time, it is evident that there is an undesirable amount of radiation. Pfahler (1) examined films carried by several hundred workers in different parts of the country, and evaluated the method. It is qualitative, or, at best, roughly quantitative, in the absence of a means for measuring accurately the darkening of the film and comparing it with standards.

An attempt to get quantitative results has been made by Mutscheller (2) using an ionization method. Such a method has the advantage that the measurements are quickly and easily made. But the electroscope must be calibrated to read in terms of the chosen unit, which is not simple. Moreover, the readings are not continuous nor additive, and the amount of radiation received must be calculated from a number of isolated measurements.

The radiation to be measured, however, is apt to vary considerably from time to time, and an accurate measurement of one hour's or even one week's output may give false ideas as to the quantity received over a long period of time. Furthermore, measurements in one or several definite parts of a room do not adequately represent the exposure of the technician. An X-ray film, worn or carried by the worker, gives a cumulative record of the radiation it receives. If this record can be translated, it is preferable to one consisting of intermittent measurements. Repeated tests of this sort will give accurate information regarding the radiation received by any one worker.

It is, therefore, desirable to devise a method by which the quantity of radiation producing the observed darkening can be measured in terms of some recognized unit. Such a method, to be valuable, should be fairly simple to use, requiring at least no more difficult calibration than the ionization method. It should not require much expensive or complicated apparatus. A high degree of accuracy, moreover, is not essential.

The scheme described in this paper has been found to meet the conditions outlined. With a simple apparatus the density of the film is actually measured and the amount of radiation necessary to cause such darkening

calculated in terms of the skin erythema dose. The method depends upon the comparison of the test films with films exposed to known quantities of radiation, the density measurements being made by means of a photoelectric photometer.

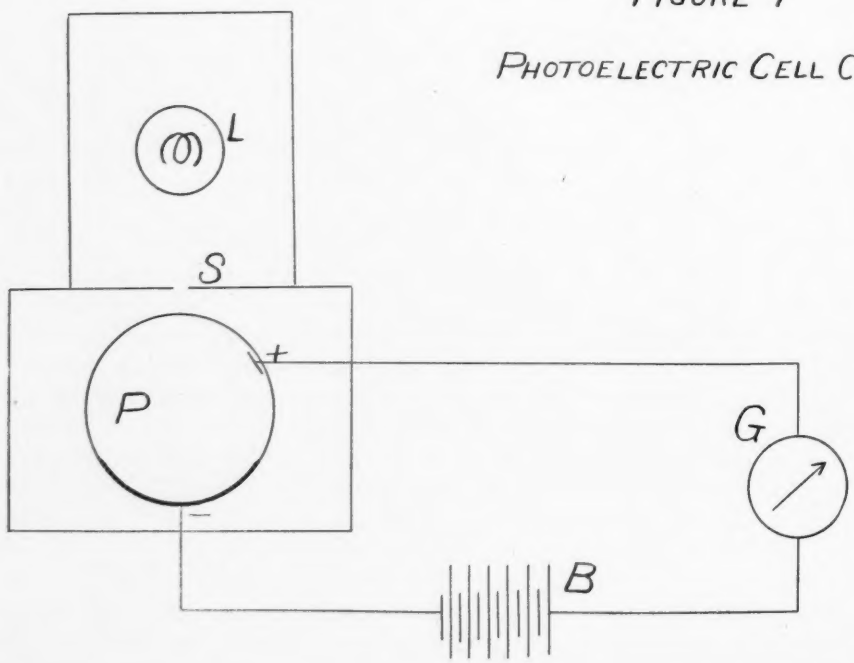
The action of the photoelectric cell, which is the fundamental part of the device, may be described briefly as follows. The cell is a vacuum tube, with two electrodes. The negative one is a film of one of the alkali metals deposited on the glass. This film possesses the property of giving off electrons when light falls upon it,—the phenomenon known as photoelectricity. The more intense the light, the more electrons are liberated. Since the film is charged negatively, the released electrons are repelled from it, and are attracted to the positively charged electrode. Thus an electric current is set up, the strength of which depends upon the intensity of the light falling on the photoelectric element. If a galvanometer is included in the circuit, the current variations can be measured, and from these the variations in the illumination can be calculated.

The circuit used is shown in Figure 1. *P* is the photoelectric cell. *L* is a lamp the light of which passes through the slit *S* and falls on the sensitive element. *B* is the battery for maintaining the potential on the cell electrodes, and *G* the galvanometer for measuring the variations in the current. The film to be tested can be interposed over the slit, thus modifying the intensity of the light falling on the sensitive surface. The apparatus is so arranged that, with a strip of unexposed film in the holder, the galvanometer gives a full scale deflection. With a darkened film, less light reaches the photoelectric cell, and the galvanometer reading is less.

The optical density of the film is defined as the logarithm of the opacity, and the opacity is the ratio between the amount of

FIGURE 1

PHOTOELECTRIC CELL CIRCUIT



light transmitted by the unexposed film and the film under investigation. Since the galvanometer reading is proportional to the light transmitted, the opacity is measured by the ratio of the galvanometer readings, for unexposed and exposed films.

It is evident, then, that without knowing anything about the characteristics of the cell or the films a sort of balance method could be used to compare films darkened by radiation. That is, the density of the test film could be measured. Then other films, exposed to the same intensity of radiation for known times, could be measured. Finally two would be found, one of which had greater density than the test film and one less. The amount of radiation affecting the film under investigation would then have been between the other two.

In making practical measurements the following procedure is carried out: A large X-ray film is cut into strips about 2×10 cm., which are wrapped in two thicknesses of black paper, and sealed. A number of these are used to make the standard series, by exposing them to a series of doses of radium or X-rays (according to which is to affect the test films). Usually about ten films are included in the standard series, giving from 0.0005 to 0.015 of an erythema dose. The remaining films are exposed to the radiation to be studied. They may be fastened to walls, desks, or operators' booths, or carried by technicians. It is often advisable to expose several films in the same location for varying time intervals. When all the exposures have been made, the films are developed, test and standard simultaneously, if possible. Using dental film holders, a large number of strips can be handled at once. If there are too many for this, time and temperature of development are carefully controlled for consecutive batches of film, using the same developer. After drying, the strips are cut to fit the slot of the photometer, and their opacities measured and densities calculated.

Figure 2 is a photograph of a set of

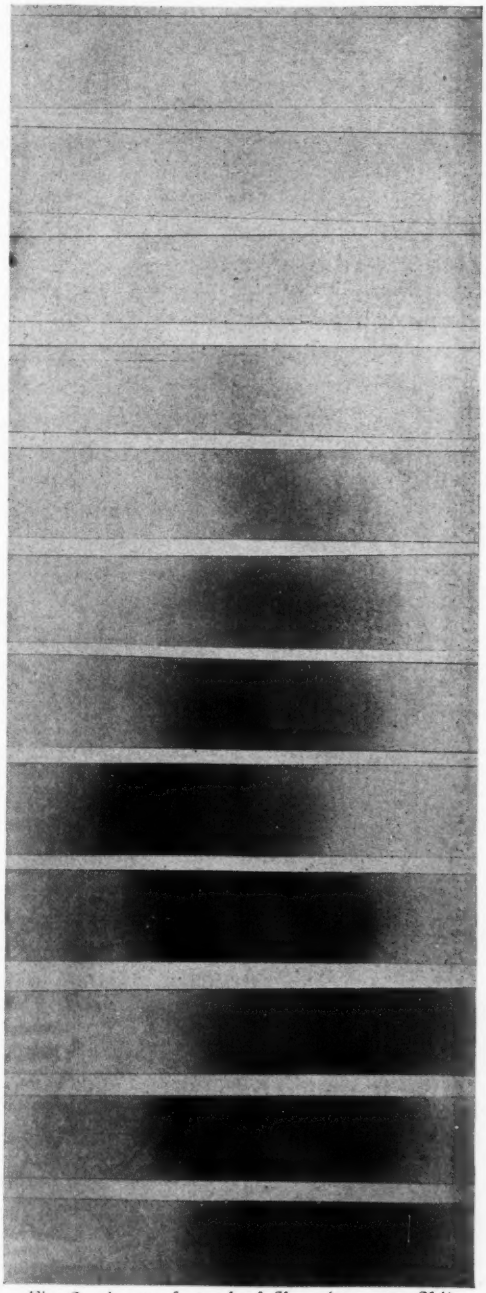


Fig. 2. A set of standard films (see page 214).

standard films; their densities are shown in Table I.

TABLE I

Exposure Skin Dose	Galvanometer Reading	Opacity	Density
0	45.0		
0.0005	34.0	1.32	0.121
0.001	23.0	1.96	0.292
0.002	16.3	2.76	0.441
0.003	10.3	4.37	0.640
0.004	8.0	5.62	0.750
0.005	7.0	6.43	0.808
0.006	6.0	7.50	0.875
0.008	4.2	10.70	1.030
0.010	3.7	12.25	1.088
0.012	2.8	16.06	1.206
0.014	2.7	16.65	1.221

The densities of the standard set are plotted as shown in Figure 3, so that the density for any exposure is shown. Then when the density is measured for any test film, the amount of radiation producing it can be read from the curve. Thus, if a test film had a density of 0.85, it had received 0.0055 of a skin erythema dose. This point is indicated by a cross on Figure 3.

The method is very sensitive, within a limited range. Less than 0.0005 of a skin dose does not affect the film sufficiently; more than 0.03 of a dose makes it too dark to be measured with the present apparatus. This, however, is a range of 60 times.

There are various factors which must be considered as potential sources of error in the method. These are:

1. Effect of conditions of development.
2. Relation between photographic and biologic effects, for different qualities of radiation.
3. Difference in effect of long and short exposures.
4. Difference in effect of continuous and interrupted exposures.

These will now be considered.

Time of development, and composition and temperature of developer have an enormous influence on the density of the film.

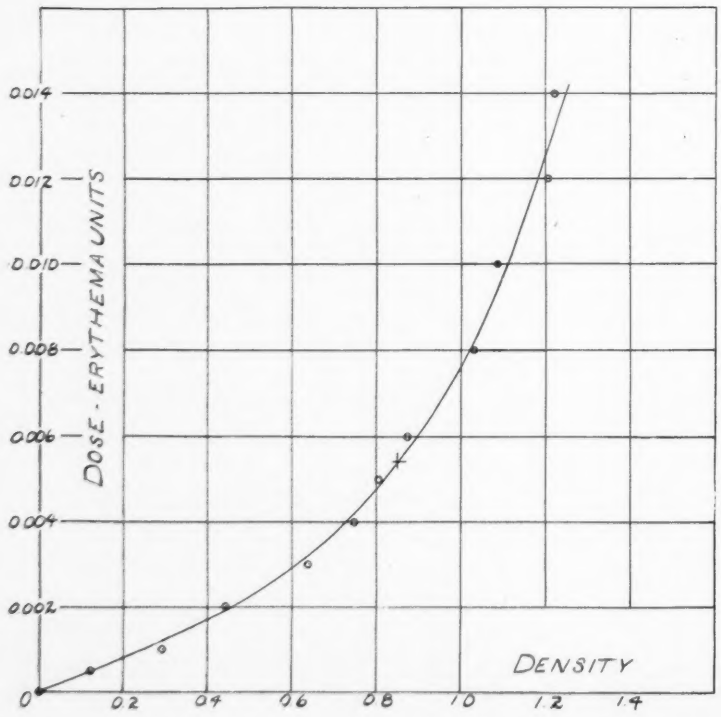


FIGURE 3

Standard Density Curve

Errors due to this source may be eliminated by developing films simultaneously, as described above. It is necessary to make a set of standards every time test films are to be measured, for it is difficult to repeat developer conditions exactly.

The question of quality is an important one. The standard films are made with radiation of a definite quality. But the radiation affecting the test films is a heterogeneous mixture of scattered and secondary rays of all sorts. Experiments were accordingly made to compare densities produced by equal intensities of radiation of different qualities, the intensities being measured in terms of the erythema unit. By means of tests on the skin of patients (3) we have established this unit for all qualities of radium rays, from the predominantly beta radiation of the unfiltered radon tube, to heavily filtered gamma rays. Preliminary experiments showed that about 0.0025 of a skin erythema dose produced a satisfactory darkening of the film. Therefore, with the same apparatus used in making the skin tests, series of films were exposed to 0.0025 of an erythema dose, for several different filters. If the density of the film was proportional to the biological effect, irrespective of the quality of the radiation, each of these films should give the same galvanometer deflection. The following results are the average of a number of tests, which do not vary much among themselves.

TABLE II

Filter		Density (per cent)
0		68
0.16 mm. brass,	1.2 mm. rubber	72
0.32	1.2	96
0.50	1.2	135
0.75	2.4	102
1.0	2.4	105
2.0	2.4	100

These figures do not agree closely. There is a steady increase in the photographic density as the softer radiation is removed, with the exception of the point at 0.5 mm. brass. The high reading for this point is not easily explained. It is possible that it may be in error on the skin test curve, and measurements are being made to check it. However, for the tests under consideration in this paper, a high degree of accuracy is unnecessary; we are interested only in finding approximately the quantities of radiation being delivered in various locations. There is no wide variation between photographic and skin test measurements; therefore, for this purpose, it is evident that the skin erythema dose and the photographic dose correspond sufficiently well throughout a range of filtration from the bare glass tube up to 2.0 mm. of brass, that is, from predominantly beta radiation to penetrating gamma rays.

The standard films are made by exposures of a few minutes, the test films are exposed for several days. The following experiment was carried out to find out whether the density depended only on the product of the time of exposure and intensity of radiation, or whether a correction factor was necessary. Filtered radon tubes were used as the source of radiation, and the same tube was used throughout the whole of an experiment. In this manner it was assured that the quality of the radiation did not change, and the relative intensity of the source was always accurately known. The tube was used first when it was of such a strength that it delivered 0.0025 of a skin dose in about ten minutes. It was then left in its holder and allowed to decay, exposures being made at intervals until it took several days to deliver the required dose. All the films were saved until the set was completed, and developed together. About eight exposures were made in each set. Table III shows the results.

TABLE III

Range of Exposure Time Hours	Number of Films	Average Deviation from Mean (Per cent)	Greatest Deviation (Per cent)
0.115 – 173	8	±3.6	+10
0.212 – 270	9	±7	−13
0.420 – 161	8	±5	+10
0.290 – 44.4	7	±2.4	±4

There was no systematic variation. From these results it may be concluded that for tests of this sort the effect of length of exposure is negligible.

For the study of the effect of intermittent radiation, two types of measurements were made. In the first, the exposure of 0.0025 of an erythema dose was made in two equal parts, at intervals from one minute to one day apart, and the density compared with that from the 0.0025 continuous dose. In the second, the dose was divided into smaller fractions, and delivered at varying intervals, corresponding more closely to the actual conditions of the test film. These tests were repeated several times. There were no consistent variations. In no case was the average deviation from the mean more than 4 per cent, and the greatest deviation observed was 7 per cent. Therefore it may be concluded that these factors do not affect the accuracy of the method.

This method does not measure the total amount of radiation received by the worker, although it affords a basis for calculating this, if desired.[1] It does give a direct measurement of the radiation to which the worker is exposed. How much of this radiation is absorbed by the tissue depends on its quality.

In determining the amount of radiation affecting workers, it is more satisfactory to have the film carried than simply attached to walls or desks (4). In the case of radium workers, a film left in a preparation room would show more radiation than was received by the technician, for the radium is often there when the workers are not. On the other hand, a film fastened in an X-ray booth makes no record of the times a technician opens a door, assists with fluoroscopy, or is exposed in some other manner.

Two types of radiation effects may occur in persons exposed to radium or X-rays,—superficial reddening of the skin, cracking of the nails, etc., due to the soft radiation, which is absorbed in the superficial layers of tissue, and systemic changes, due to the more penetrating rays. It is desirable to be able to differentiate between the amounts of each being received. This can be done by having part of the film covered with a filter which will absorb all the soft radiation. A very practical arrangement, suggested by Mr. A. L. Miller, of the Standard Chemical Company, is shown in Figure 4. The film is worn attached to an eyeshade, since it is thus exposed to more radiation than if carried in a pocket. (The face is usually the most exposed part of the body, except the hands, since it is necessary to watch what is being done. Also, in a pocket, the material of the garment, and possible other things carried there, may filter out much of the soft radiation.) A filter of 2 mm. of brass or 1 mm. of lead, covered with rubber,

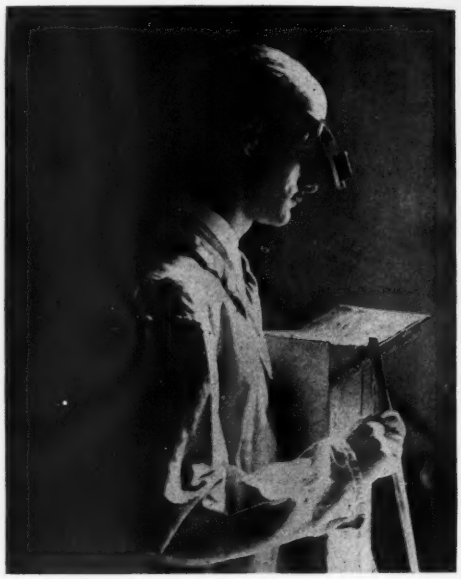


Fig. 4. The film as worn attached to an eyeshade where it is exposed to more radiation than if carried in the pocket.

[1] If this is to be done, it would be advisable to have the technician carry films on different parts of his body, for the quantities of radiation reaching the face, chest, and abdomen may be quite different.

is fastened over the middle of the film, on both sides. Figure 5 is a photograph of films worn in this fashion. These, when measured, show the total radiation received on the darker portion, and the gamma radiation on the lighter. The films illustrated, measured by the standard curve of Figure 3, show the following intensities:

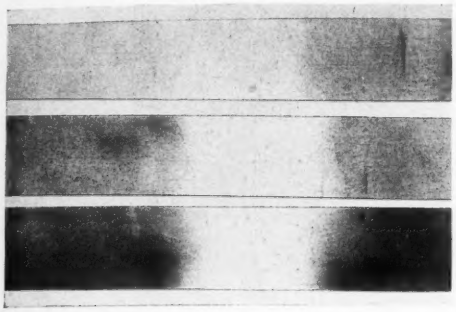


Fig. 5. Photograph of films worn as shown in Figure 4.

Film	Total Intensity Skin Dose	Gamma Intensity Skin Dose
1	0.0020	0.0006
2	0.0031	0.0010
3	0.0041	0.0012

The work herein described has been done with radium. Of course, the method is equally applicable to X-rays, if the standard films are exposed to X-radiation. It is probable that radium standard films could be used to measure X-ray exposures, since the density of the film is independent of the quality of the radiation, over the large range shown in Table I. This point, however, is still to be tested.

REFERENCES

1. PFAHLER: Effects of X-rays and radium on the blood and general health of radiologists. Am. Jour. Roentgenol. and Rad. Ther., 1922, IX, 653.
2. MUTSCHELLER: Further studies on physical standards of protection against roentgen-ray dangers. Radiology, 1926, VI, 314.
3. DEAN: Results of skin tests made to determine an objective dose for radium radiations. Am. Jour. Roentgenol., and Rad. Ther., 1923, X, 654.
4. VIOL: Protection of technical assistants and of those handling large quantities of radium or radon. Am. Jour. Roentgenol. and Rad. Ther., 1926, XV, 345.

ROENTGENOLOGICAL STUDY OF THE LARGE INTESTINE[1]

By S. B. WHITLOCK, M.D.
Roentgen-ray Department, Sarah Leigh Hospital and Clinic, Norfolk, Va.

JUST as diagnosis in all parts of the body is becoming more accurate, so is the determination of large intestine pathology becoming more certain, and in this paper I wish to present what can be expected and revealed by a study through the medium of the roentgen ray. Unlike the stomach, the large intestine is subject to great variations in both normal and pathological conditions, as revealed by roentgen study, and I shall endeavor to make clear some points as to both.

The study of this canal will be presented under the following headings: normal; abnormal, which includes variations in shape and position, due to faulty formation and arrested migration, but which are not truly pathologic; tumors; diverticulosis; infectious and inflammatory processes; chronic stasis, with accompanying phenomena, and miscellaneous congenital deformities.

In observing over three hundred cases, which I have selected for this study, there is one fact established, namely, every large intestine has the following divisions: appendix, cecum, ascending, transverse, descending, and sigmoid colons, and rectum. As students we were taught this and observed it in our anatomical dissection, but with the roentgen study one can demonstrate some interesting conditions as to location, length, capacity, and topography, which, while not pathologic, may at times be passive factors in certain disease conditions. For example, an exceedingly long loop of one portion may be a favorite site for an intussusception, or a volvulus. A faulty migration may produce, to the clinician, some mysterious signs; for example, a left-sided, non-rotated cecum with attached appendix would give this difficult condition.

A brief review of the embryology is appropriate at this time. The 5 mm. embryo, three and one-half weeks old, has so developed that its constriction from the yolk sac has proceeded so that a portion of the digestive tract anterior to the sac can be recognized as the stomach, and a portion posterior, as the intestine. At first, the intestine is a tube, without coils or bends, but since in later stages the intestine grows much more rapidly in length than the abdominal cavity, coiling of the intestine becomes necessary. The growth of the intestine itself results in its being thrown into a loop opposite the point where the yolk stalk is connected with it, the loop projecting ventrally into the portion of the cœlom cavity which is connected with the umbilical cord, and being placed so that its upper limb lies to the right of the lower one. Upon the latter, a slight pouch-like outgrowth appears, which is the beginning of the cecum, and marks the line of union of the small and large intestines. At the 40 mm. stage the cecum is thrown over toward the right, a position which it retains until the fourth month after birth. The portion of the large intestine which formerly projected into the umbilical cœlom now lies transversely across the upper abdomen, having the remaining portion of the small intestine below it. The elongation continuing, the secondary coils of the small intestine become numerous, and the lower portion of the large intestine is thrown into a loop, which extends transversely across the lower part of the abdomen, and represents the sigmoid. At birth, this portion of the large intestine is relatively much longer than in the adult, amounting to nearly one-half of the colon, but after the fourth month following birth, a re-adjustment of the relative lengths of the parts of the colon occurs, the

[1]Read before the Medical Society of Virginia, Richmond, Va., Dec., 1925.

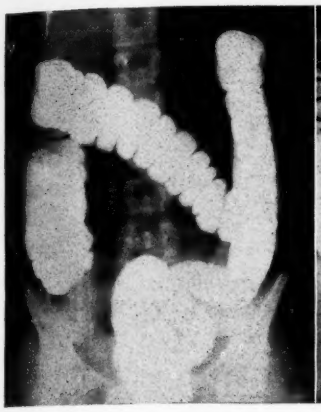


Fig. 1. Normal large intestine, showing cecum, ascending, transverse, descending and sigmoid colons, and rectum. Note relative normal positions of hepatic and splenic flexures.

Fig. 2. Normal; unusually long, but relative positions are the same. Observe how the filled sigmoid rises out of the pelvis.

Fig. 3. Normal.

sigmoid becoming shorter, and the rest proportionally longer, whereby the cecum is pushed downward until it lies in the right iliac fossa, the ascending colon thus being established. A failure of the readjustment of the different parts of the colon may occur, in which case the cecum will retain its embryonic position.

To study the large intestine roentgenologically, we have two methods at our disposal, namely, the contrast meal and the enema. Each has its place, but the enema constitutes the larger asset. The meal is used when we are called upon to determine motility and stasis, while the latter is used to investigate neoplasms, inflammatory processes, adhesions, fistulæ, and abnormalities. We sometimes use the combination. The patient is placed on his back on a horizontal fluoroscope and in normal conditions we observe the following phenomena: The head of the enema appears in the rectum, as a pear-shaped shadow, which increases in size and completely fills the ampulla to distention. It now shows a constriction due to the rectosigmoid apparatus. The fluid next reaches the sigmoid, which is seen to unfold. The outlet from the ampulla to the pelvic colon is variable, appearing either in the middle, or to the right or left. The pelvirectal angle is most readily observed when the sigmoid is far to the left, so there is no overlapping. Normally, the sigmoid is seen to rise several inches in the abdomen, this being due to full distention and the internal pressure. We especially look for this, as failure to rise is strong evidence of some pathology. As soon as the stream enters the descending colon its rate is almost twice as rapid as heretofore, and it passes upward, undisturbed, to the splenic flexure. The rate may be so rapid that, if not on guard, we may overlook a lesion in the lower descending colon. It next passes downward across the transverse colon to the hepatic flexure. In the mid-portion of the transverse colon we sometimes encounter a defect in the stream, this being due to pressure from the spinal column. It can be proven by tilting the patient to either side, and relieving the pressure. Leaving the hepatic flexure, it rapidly fills the ascending colon and cecum. This tortuous and tail-spin course can be examined under the fluoroscope in about five minutes, thus leaving ample time to reinforce our information

Fig. 4. Normal.

Fig. 5. Faulty migration. Observe high-placed cecum, and non-formation of the ascending colon, due to failure of the cecum to descend into the right iliac fossa.

Fig. 6. Faulty migration and rotation. The cecum is to the left of the midline. This condition is met with in cases of left-sided appendicitis.

with roentgenograms, before there is a desire to expel. It is the lumen which appears roentgenologically. The opaque enema constitutes an active mold of the bowel cavity. Of super-importance is it to have the patient properly prepared, for an intestine which contains fecal matter or any considerable amount of gas will tend to displace the mold and give the pseudo-filling defect. A cathartic of mild degree, given the previous night, and a cleansing enema on the morning of the examination, constitute the preparation. We should not attempt to make the examination too rapidly, as forceful pressure may produce pain and undue spasm, and great care must be taken in differentiating spasm from true pathology.

Next, turn to the abnormal, but not truly

Fig. 7. Partial descent of the cecum. Arrested development at this midway position.

Fig. 8. Extra loops. Observe the doubling of the descending colon, and note the contrast media in Figure 9 retained in the extra loop, after partially expelling enema.

Fig. 9. Extra loop described in Figure 8.

Fig. 10. Carcinoma. Showing large filling defect in ascending and transverse colons, and all of hepatic flexure. Female, aged 60.

Fig. 11. Early carcinoma of ascending colon. Male, aged 45. Confirmed at operation.

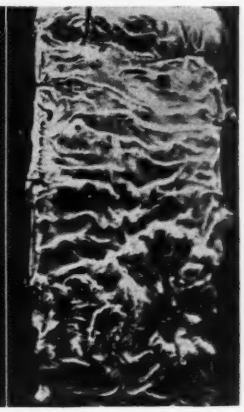


Fig. 12. Pathological specimen of Figure 11, showing gross lesion in lower portion of the section of intestine removed.

pathologic states. Here we sometimes observe a colon which will show defective formation, rotation and migration, where the embryonic process was not completed. The ascending colon and cecum in the illustrations are shown to the left of the midline directly beneath the liver, and highly placed on the right side. In this same group we include the redundancies and extra loops. Here, the transverse, descending and sigmoid colons may be looped to give various configurations. The importance of these are of special interest to the clinician, in that they may lead to pathologic conditions,

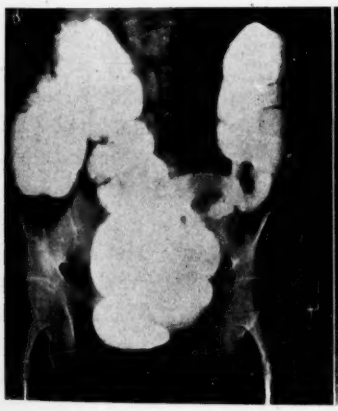


Fig. 13. Carcinoma. Large filling defects in transverse and descending colons. Advanced. Male, aged 48.

Fig. 14. Carcinoma of descending colon. Female, aged 48. Observe almost complete obstruction. Difficult to give the enema, and get the contrast medium through to the distal side of growth. Confirmed at operation.

Fig. 15. Carcinoma, at junction of descending and sigmoid colons. Male, aged 30. Confirmed at operation. Patient died several months later from metastases. Activity of lymphatics at this age accounts for early metastases.

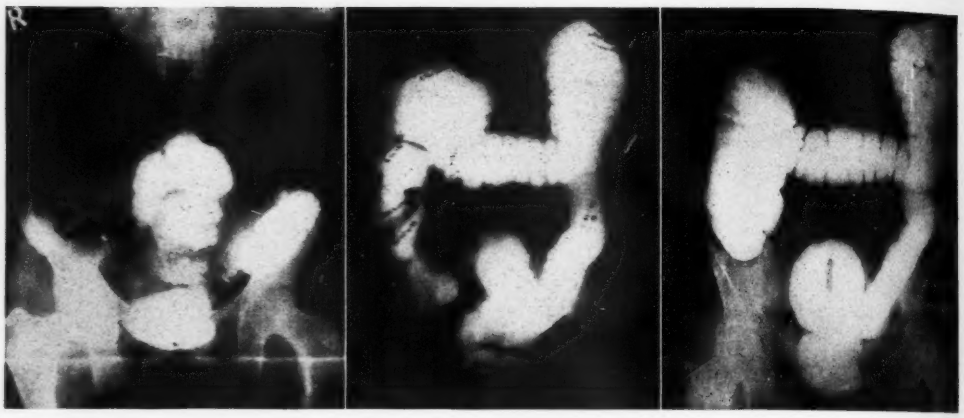


Fig. 16. Carcinoma, located in mid-rectum. Note filling defect with spasticity in proximal region of the rectum. Female, aged 39. Confirmed at operation.

Fig. 17. Tuberculosis of cecum and appendix. Male, white, aged 24. Confirmed at operation.

Fig. 18. Catarrhal colitis. Note the smoothness of the distal portion of the intestine.

as heretofore mentioned. The demonstration of ptosis, as in the case of the stomach, leads to a debatable question. A slightly elongated transverse colon will reach the pelvis when completely filled, so this is not a true ptosis. The best criterion of large intestine ptosis is the location of the hepatic and splenic flexures. Many cases of complete transposition of the entire large intestine have been reported in the literature.

CARCINOMA

Malignancy of the large intestine presents an extensive field for roentgen study, and one of the most perplexing problems in our interpretations. It is more difficult to make a diagnosis of carcinoma of this region than in the stomach. Malignancy of the large intestine is a relatively infrequent lesion. In a recent report of the Vienna General Hospital covering 40,000 autopsies, there were 3,585 cases of carcinoma, of which 343 (about 10 per cent) were in the large intestine. In order of frequency they are as follows: rectum, sigmoid, cecum, splenic flexure, transverse, descending and ascending colons. Pathologically, we have the cylindrical-cell adenocarcinoma, the small cell, soft medullary, the scirrhous and the colloid. The soft medullary are the most rapid growing in comparison with the others. The scirrhous are small and have a tendency to encircle the gut. They produce the napkin-ring form and cause most extensive obstruction. They are the easiest to diagnose with the roentgen ray. Metastases from the large intestine are far less frequent than from the stomach, and sometimes never occur. However, in young subjects the lymphatics are more active and metastases are more likely to occur. I have a case in my series of a male, aged 30, in whom metastases occurred very rapidly from a carcinoma of the sigmoid.

In roentgen diagnosis of carcinoma, the sign of prime importance is the filling defect. If a tumor springs from the wall of the lumen, it will thus occupy a space which would otherwise be visualized by the opaque medium, and this incomplete luminal shadow is the filling defect; a similar defect will be produced should the neoplasm cause a thickening of the wall. Obstruction is the next important sign. This is observed in a high percentage of intestinal malignancies. Incomplete obstruction will produce some

retardation of the enema at the point of stenosis. It is interesting to observe that a stenosis which will permit the fecal stream to pass in the physiologic direction, may completely block the enema. The stenosis

Fig. 19. Ulcerative colitis. Observe the defects in the sigmoid, due to organic changes that have taken place in the mucosa. This is the "sausage-shape" intestine. Confirmed.

is accustomed to the downward passage and accommodates accordingly. The enema sets up a spasm, which may close the already existing narrow channel. In observing the opaque stream we see a characteristic arrest at the point of hindrance, then a slight dilatation of the bowel below the growth, from which a finger-like projection of the column will be seen, which moves upward and fills the gut above, thus leaving the filling defect sandwiched between the complete filling below and above the lesion. The overfilling at the defective region may produce pain and tenesmus.

The third aid is palpation. Palpation for a possible mass at the point of filling defect will help in our summary of findings. Tenderness is sometimes elicited. Spasticity in the region, especially if proximal to it, is also a helpful factor. However, given all of these signs, we should not make a diagnosis of malignancy too hastily, but go about it by a careful process of elimination. In spite of all this, sometimes it is absolutely impossible to make a clear-cut diagnosis so we should present our findings to the clinician, and let him weigh the clinical and roentgen evidence. Some of the rarer benign tumors, such as fibromata, adenomata and myomata, from the roentgen signs

Fig. 20. Same as Figure 19, after partial expulsion of enema.

alone, are impossible of distinction from carcinoma. Along with this difficult class may be mentioned a benign inflammatory mass, occurring with ulceration, tuberculous and luetic tumors, adhesions, and diverticulitis. This deliberation in diagnosis should not constitute a black mark against the roentgenologist, when one recalls that a pathologist or surgeon cannot always differentiate a gross pathologic specimen. Caution has to be observed against mistakes from pseudo-filling defects, which at times may resemble carcinomata. Certain areas and conditions render the diagnosis even more difficult, especially in the pelvic region, where palpation is difficult due to the overlying symphysis pubis, and in the hepatic flexure, from the overlying liver.

The enema is the choice route, but in doubtful cases it is wise to re-examine the following day with a meal from above, for confirmatory helpful points. Never make a diagnosis by the meal alone, for this is not

always certain to give a continuous trail of contrast medium, even in a normal subject. The so-called streaming of the head of the meal has been mistaken for a pathological narrowing. Should the stenosis completely block the enema, then the meal has to be relied upon.

Fig. 21. Diverticulosis. Observe the multiple projections of the descending colon filled with barium.

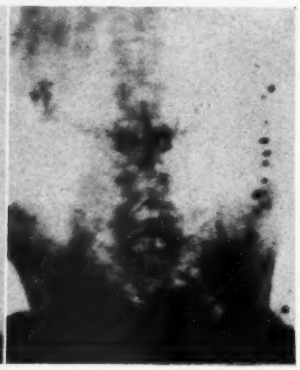


Fig. 22. Same case as Figure 21, showing retention of the barium in the diverticula, after expulsion of the enema.

TUBERCULOSIS

The proximal portion of the colon is the most frequently involved; the ileocecal valve, cecum, appendix and ascending colon are the favorite sites. The ulcerative and fibrous types produce an irregularity of the bowel contour at an early stage, and give certain roentgenologic appearances that are helpful. These are filling defects, spastic phenomena and obstruction. On examining with the enema we observe an irregular filling, accompanied by a characteristic narrowing. There is invariably an absence of normal haustrations. Tuberculosis at times may be difficult to distinguish from carcinoma of the cecum, and chronic ulcerative colitis. With the above roentgen evidence, lesions should be looked for in other parts of the body.

The roentgen signs of colitis are local or general narrowing of the colon, which is very smooth and unhaustrated, and in spite of the narrowing there is a very rapid filling. Chronic ulcerative colitis furnishes more interesting roentgen study than the milder catarrhal types. The chronic ulcerative type may show the entire large intestine as a smooth, narrowed tube, for which we reserve the term "sausage-shaped colon." These findings are the result of chronic organic changes that have taken place in the mucosa.

CONSTIPATION

The roentgen study of this condition can be a valuable adjuvant to the clinician in his treatment of this troublesome complaint. The value is to show the type of constipation, whether it is spastic, atonic or obstructive. In the spastic, the whole or some portion shows narrowing, and deeply scalloped with haustra, which indicate a diffuse spastic contraction. A smaller quantity of fluid is required to fill the bowel. This is the type observed in neurotics, brain workers, and those who have over-used cathartics. Contrast this with the atonic type, which shows the colon in a state of dilatation and sluggishness, with a smooth outline. The demonstration of adhesions is also of value, these causing obstructive constipation. To demonstrate the absence of the rectosigmoid

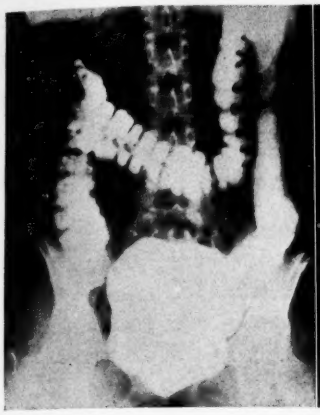


Fig. 23. Spastic constipation. Showing spasticity of proximal half, with dilatation and relaxation of distal half.

Fig. 24. Loss of rectosigmoid apparatus, with resulting constipation. Note the capacity of the rectum and sigmoid.

Fig. 25. Adhesions between small and large intestines. This shows firm adhesions between duodenum and transverse colon; a cause of constipation.

apparatus is also helpful. In this type there is no line of demarkation between the rectum and pelvic colon. This is quite characteristic and the two regions appear as one pouch.

DIVERTICULITIS AND DIVERTICULOSIS

These conditions are not so infrequent, occurring mainly in the descending colon and sigmoid, but any portion of the large intestine may show them. LeWald, of New York City, has recently reported a right-sided diverticulitis, which may be mistaken clinically for appendicitis or cholecystitis. The roentgen appearance of diverticula is characteristic. We observe small, rounded shadows in the affected area, which are connected with the barium-filled bowel. The shadows are the opaque salt which has run into the small projections. If this condition

Fig. 26. Descending colon pushed toward midline, due to pressure from mass in abdominal cavity (ovarian cyst). Used to show differential diagnosis.

Fig. 27. Hirschsprung's disease, or megacolon. Male, aged 10, colored. Colon held 2½ gallons of fluid, without discomfort.

Fig. 28. Same as Figure 27, showing enormous dilatation of the rectum.

is suspected, we allow the contrast enema to be expelled and in half an hour take another film. This will frequently bring out a larger number, as some may have been hidden by the overlapping bowel shadow. It is necessary to make a distinction between diverticulitis and diverticulosis. The former name is used when there is complicating inflammation in conjunction with the latter. There is usually more spasm with the diverticulitis.

HIRSCHSPRUNG'S DISEASE

This is a congenital idiopathic dilatation of the colon. Associated with this is the megasigmoid, in which the dilatation is located only in the sigmoid. The latter occurs more frequently than the complete dilatation of Hirschsprung. These are readily diagnosed with the barium enema There is marked dilatation with little or slight haustration. A case in my series is that of a colored boy, aged 10, in whom the colon easily held two and a half gallons of the barium enema without the slightest discomfort.

Chronic intussusception can be diagnosed with the roentgen ray. Foreign bodies and fecaliths are occasionally met with. I have not included the vermiform appendix in this study, as this is an entity in itself.

BIBLIOGRAPHY

1. McMurrich, J. Playfair: Development of the Human Body. Fourth edition.
2. Carman, Russell D.: Roentgen Diagnosis of the Alimentary Canal. Second edition.
3. Lynch, Jerome: Diseases of the Colon and Rectum. Second edition.
4. Kantor, John L.: Clinical study of some common anatomical abnormalities of the colon. Am. Jour. Roentgenol. and Rad. Ther., Nov., 1924, XII, 414.

INTRA-UTERINE FETAL DEATH[1]

A CLINICAL-RADIOLOGICAL STUDY

By IRVING F. STEIN, M.D., and ROBERT A. ARENS, M.D.
Associate Attending Gynecologist and Obstetrician, and Roentgenologist, Respectively,
Michael Reese Hospital, Chicago

THE subject of the diagnosis by roentgenography of intra-uterine fetal death has received rather scant and sporadic attention from obstetricians and roentgenologists up to the present. Spalding and Horner in independent original communications reported three cases each of fetal death at about the same time, 1922, —each describing a so-called pathognomonic sign. Since then a few additional observers —Greenhill, Doub, Moss, Portes and Blanche, Bourland and Spangler—have written upon the subject corroborating Spalding and Horner. When one considers the exceedingly small number of cases by the two last mentioned and the smaller number reported subsequently by the other observers, none of whom had over two cases, it is rather interesting to reflect that what is supposed to be a pathognomonic sign of intra-uterine fetal death has been so unconditionally accepted.

Spalding states: "It seems that very shortly after intra-uterine death, the brain tissue shrinks, which produces a typical overlapping of the fetal skull bones. This overlapping of the fetal skull bones seems to be pathognomonic of the condition of intra-uterine death and gives a picture quite different from the overlapping produced by molding. With the X-ray, the decreased size of the fetal head from postmortem shrinking can be determined because the cranial bones remain nearly the same size and shape. As the head shrinks, the bones overlap at times to an astonishing distance. The radius of curvature of the shrunken head becomes obviously smaller than that of the unchanged cranial bones. When both the above changes are noted in the X-ray picture it seems justifiable to conclude that the child is dead, and such has been our experience of the study of 21 babies *in utero*. In this series, three babies were dead and presented the typical findings; 18 were alive, of which 17 showed no changes of the fetal head and suture lines. One baby showed marked overlapping of the skull bones due to molding caused by a long first stage of labor, but in spite of this overlapping, the skull bones showed no disproportion in relation to the bulk of the contents of the skull." Horner reports somewhat similarly: "In three cases where fetal death was suspected, X-ray revealed overriding of the skull bones, with asymmetry of the head.

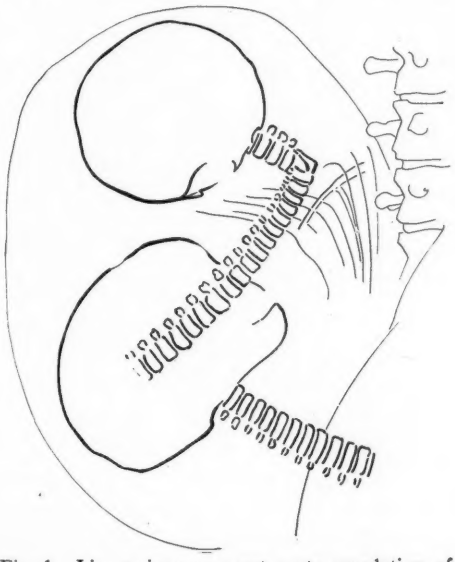


Fig. 1. Live twins; apparent acute angulation of cervical spine (upper twin), giving illusion of decapitation.

[1]From the Adolf Stein Memorial for Research in Roentgenology. This work was supported by a grant from the Otto Baer Fund for Clinical Research.
Paper read before the Radiological Society of North America, at Cleveland, December, 1925.

This to me indicated fetal death and the subsequent course bore out my belief. Therefore," he concludes, "overriding of the skull bones with cephalic asymmetry are signs of fetal death and are the only positive signs of intra-uterine death." He does not mention the number of cases in which the fetus *in utero* was dead and the pathognomonic sign was absent.

Fig. 2. Lateral view, live fetus; placental shadow on posterior wall near fundus; double apparent acute angulation of spine which simulates the picture of postmortem fetal collapse.

In a previous communication read before this Society, we called attention to the varying disproportioning of fetal skeletal structures both as to size and shape, due, not to actual bone changes, but to the relation of the various bony structures to the plane of the recording film when the exposure was made. It is obviously impossible to make an exposure of the fetus *in utero* which is anatomically correct, consequently it is not surprising, or should not be, that astonishing apparent malformations should be revealed that are caused by no other factor than distortion. In fact, this can be so exaggerated that twins have been erroneously diagnosed by Werner because of the presence on the film of two spine shadows. Kermauner, after delivery of only one macerated fetus, in the case of Werner's patient, expressed his opinion that the second "spine" shadow was produced by ribs. One of our own series of cases also illustrates even more graphically the false conclusions at which one may arrive as a result of distortion of the fetal shadow, namely, an apparent decapitation of one of a set of live twins *in utero* (Fig. 1).

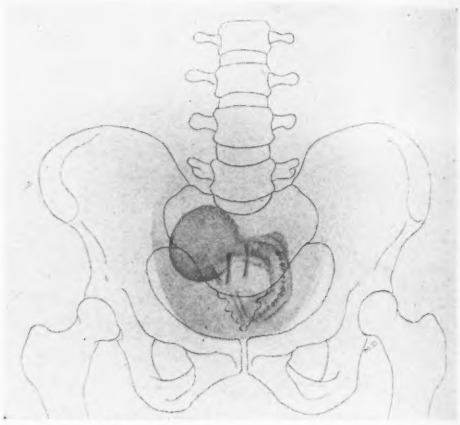


Fig. 3. Dead five-months fetus; acute angulation of vertebral column; no overlapping of head bones.

For the purpose of this study we have selected from our roentgen files of over 700 pregnancies, eleven cases of intra-uterine fetal death, and for comparison ten cases in which the fetus was delivered alive, but in which the films revealed evidence that would be considered characteristic of fetal death. When we attempted to diagnose fetal death from the roentgen aspect alone we found ourselves entirely at sea. The so-called pathognomonic signs of fetal death appear on the films of those patients who subsequently delivered live babies, and many of the unquestionably clinically recognized dead feti failed to show any evidence whatever of cranial shrinkage or body collapse, this latter sign having been held by us as of greater value than the former. Fetal collapse is suggested in the film of E. R. (Fig.

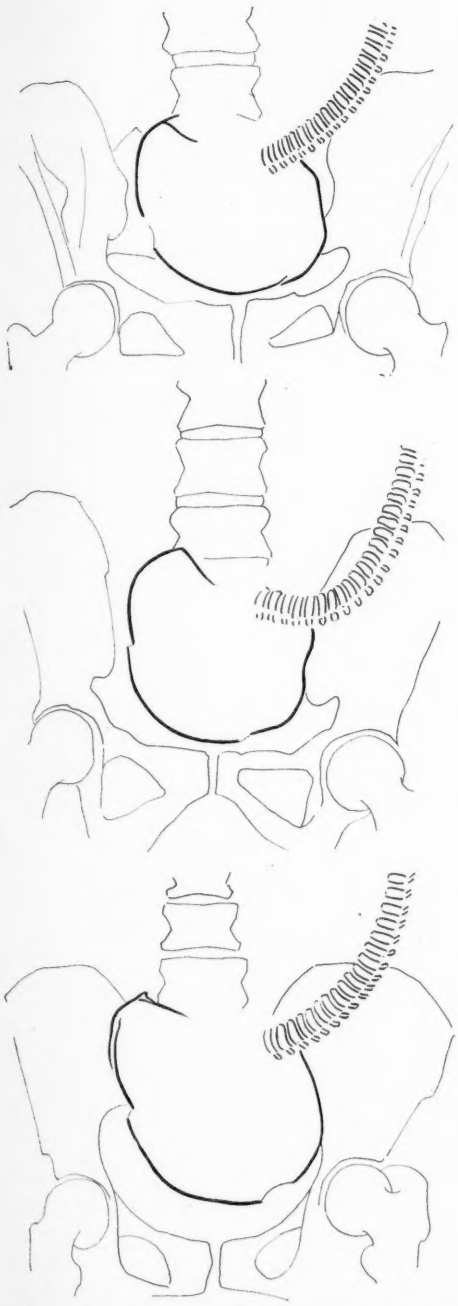


Fig. 4 *(A)*. Fetus dead twenty-four hours; no overlapping of bones. (At top.)

Fig. 4 *(B)*. Fetus dead ninety-six hours; slight overlapping of bones evident. (Middle.)

Fig. 4 *(C)*. Fetus dead five days; shows typical overlapping of skull bones and asymmetry of head.

2), in which case a live baby was subsequently delivered, while in Figure 3 a 5-months fetus, retained in the uterus after death until the seventh month, illustrates the acute angulation of the spine character-

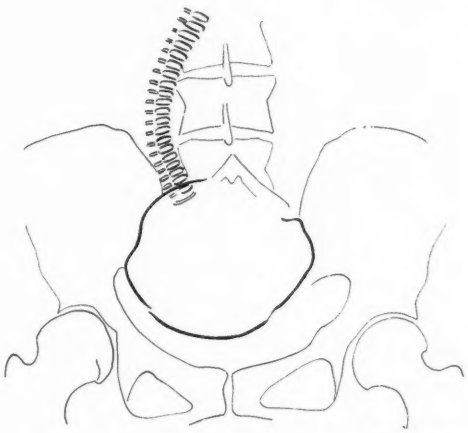


Fig. 5. Live fetus; slight overlapping of skull bones, with distention of fontanel.

istic of body collapse but without overlapping of skull bones.

Figure 4 *(a)* is a tracing of a roentgenogram of M. S., taken October 30, 1924, showing no overlapping or collapse, heart tones having been last obtained twenty-four hours before. Basal metabolic rate was +18 per cent. Figure 4 *(b)*, taken ninety-six hours after fetal death, shows pseudo-overlapping of the cranial bones, while Figure 4 *(c)*, taken at one hundred twenty hours, shows overlapping of skull bones typical of the signs described by Spalding and Horner, a macerated fetus being delivered at the end of eleven days. In this instance the overlapping became evident only five days after fetal death. This has been our experience throughout: Only after considerable maceration had occurred, and long after any doubt of fetal death remained clinically, were the so-called pathognomonic roentgen findings present, if at all.

Figure 5 shows overlapping of parietal bones with slight distention of the anterior

fontanel in a live fetus, and Figure 6 a well molded head with marked overriding and asymmetry, also in a live fetus. However, Figure 7, in which the fetus had been dead four days, disclosed no sign of abnormality

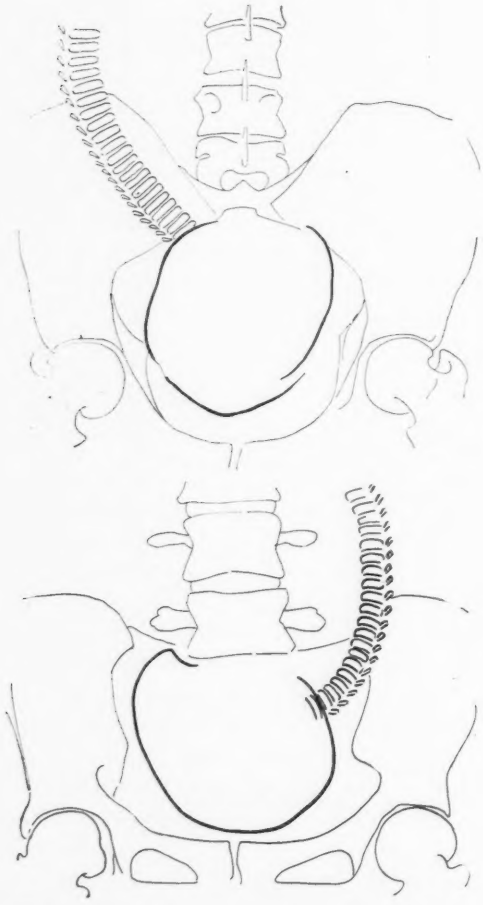


Fig. 6 (above). Live baby; well molded head; first stage of labor; marked overlapping of skull bones and asymmetry of head.

Fig. 7 (below). Fetus dead four days; no overriding or asymmetry.

on the film, and in Figure 8 (dead fetus) showed slight asymmetry of the head with pseudo-overlapping of the skull bones in the dorsal posture, but none in the lateral view. It is evident from the foregoing that posture, or the relation of the anatomical planes of the fetal structures to the plane of the recording film, is accountable for tremendous distortion of shadows so that an apparent overriding may become indistinguishable from that which may occur in

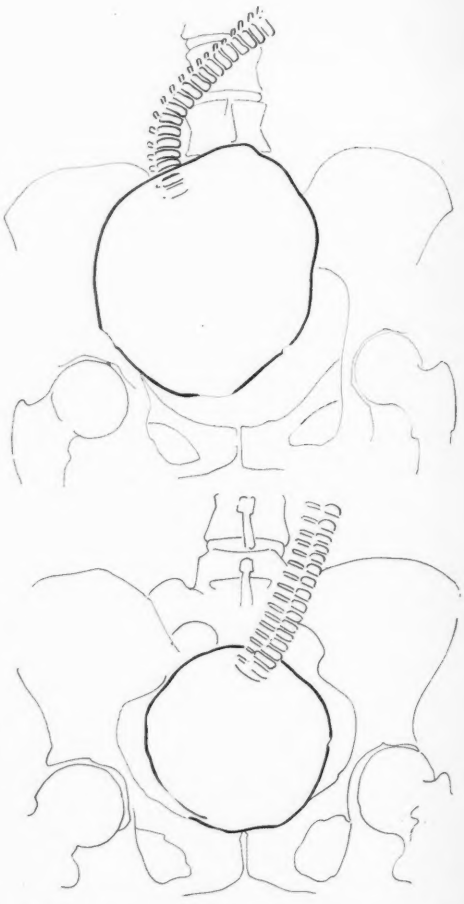


Fig. 8 (above). Dead fetus; slight asymmetry of head, with pseudo-overlapping.

Fig. 9 (below). Live baby; parietal overlapping frontal bone; molding.

the dead fetus due to maceration, or may distort an actual overriding so as to appear within the range of normal.

In the course of our observations we thought perhaps a certain amount of maceration was required before the typical path-

ognomonic signs of Spalding and Horner appeared, as in Figures 4 *(b)* and 4 *(c)* they were absent ninety-six hours after fetal death, but were present after one hundred twenty hours. Further observation convinced us that the signs were quite unreliable, as illustrated in Figure 10, which reveals only slight overriding and no asymmetry. This patient appeared in a clinic a short time ago and gave a very definite history of violent fetal motion followed by cessation of motion nine days before our examination. On palpation of the fetal head in the lower abdomen *definite crepitation of the cranial bones* was elicited. This phenomenon was successfully demonstrated to and confirmed by four other physicians. The basal metabolic rate of this patient was +3 per cent, normal for the non-gravid woman but a distinct deficit of about 30 per cent for late pregnancy, a low basal metabolic rate in the last trimester, according to Baer, being a valuable sign of fetal death.

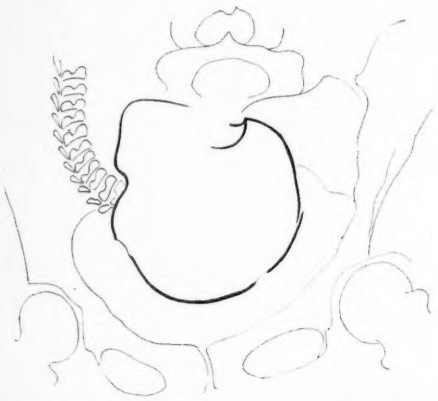


Fig. 10. Fetus dead one week; crepitation of head bones obtained through abdominal wall; slight overriding, but no asymmetry of skull.

The roentgenologist should not require detailed clinical data such as engagement of the head, absence or presence of heart tones, etc., to detect a *pathognomonic* sign. Without data, cases such as are depicted in Figures 11 and 12 would doubtless be incorrectly interpreted. If the signs described by Spalding and Horner are of value, they should appear regularly after a certain degree of maceration has taken place. In Figure 13 the fetus, dead twenty-four hours, showed no overlapping of skull bones, or asymmetry of the head, nor did one dead forty-eight hours (Fig. 14), but in Figure 15 (in a case where fetal death occurred twenty-four hours before the roentgen film was taken) we see slight alteration of the

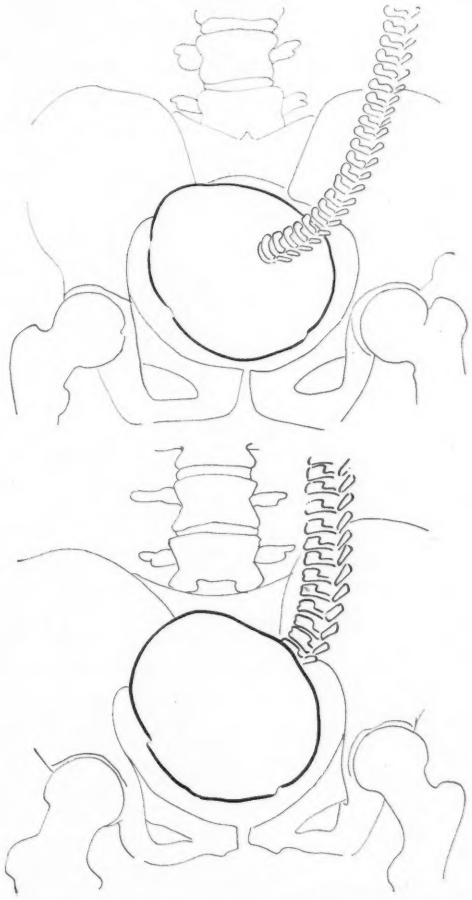


Fig. 11 (above). Live baby, dorsal view; first stage of labor; pseudo-overlapping of skull bones; molding.

Fig. 12 (below). Live baby; long first stage of labor; pseudo-overlapping of skull bones.

head outline and pseudo-overlapping, as in molding. From the study of this group of 21 cases—comprising 11 cases of intra-uterine fetal death and 10 cases in which a live fetus was delivered but giving apparent cessation of fetal motion. Sometimes, as in our case No. 708, this is preceded by a feeling of excessive fetal motion. Upon examination the uterus is usually rather firm, a certain amount of retraction having occurred, and a peculiar stillness is noticeable upon auscultation over the uterus. No heart tones or fetal shock can be elicited. Rarely does one obtain crepitation of the cranial bones by palpation of the head above the pubes, as we report in one case, but upon bimanual examination, if the fetus is macerated the fetal head may feel like a bag of

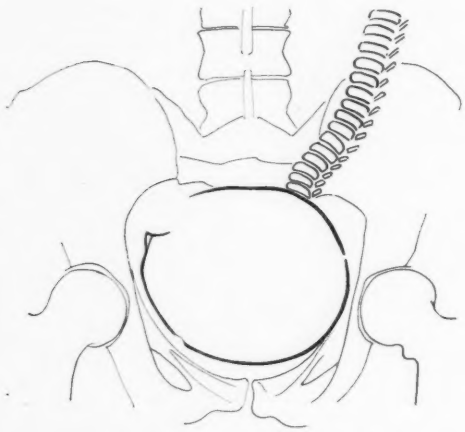


Fig. 13. Dead fetus; no overlapping of bones or asymmetry of head.

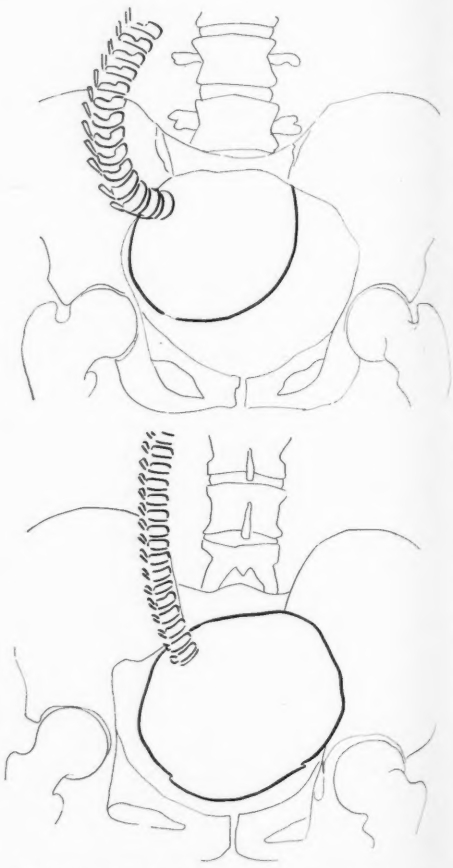


Fig. 14 (above). Fetus dead forty-eight hours; no evidence on film of asymmetry or overlapping.

Fig. 15 (below). Fetus dead twenty-four hours; pseudo-overlapping of bones similar to molding of head.

evidence on the roentgenograms of fetal death—we believe that both Spalding and Horner drew premature conclusions based upon only three cases each, and that this has been accepted generally without reserve because, first, it appears reasonable that such changes might naturally be found, and second, because few observers have had large enough series of roentgenograms in pregnancy to warrant a comparative study. If the observation made by Baer, that when the fetus dies the basal metabolic rate drops to the normal non-gravid rate, is confirmed by further experience, this would seem to us to be a far more certain sign. In two cases of this series, Nos. 708 and 621, the rates were +3 per cent and +18 per cent, respectively, as compared with rates of +33 to +35 per cent, the average of 44 cases of normal pregnancy, near term, observed by Baer.

The diagnosis of intra-uterine fetal death is usually first suspected by the history of

loose bones which, according to De Lee, is the only positive sign of fetal death. If the fetus has been dead for some time, the

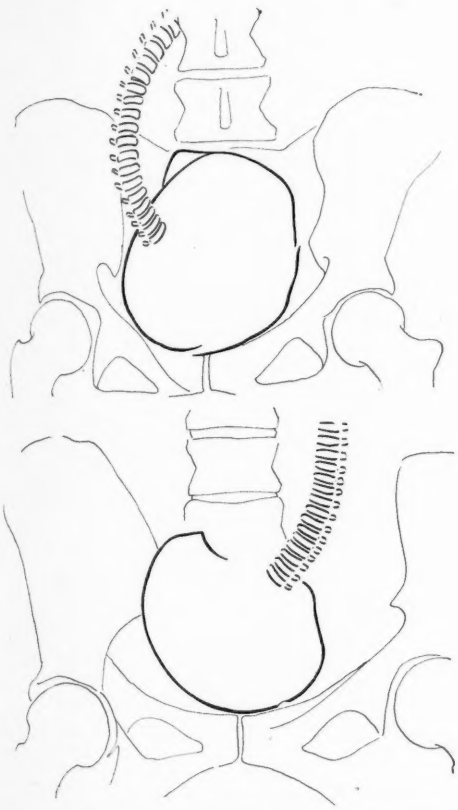


Fig. 16 (above). Live baby, post-mature; asymmetry and overlapping of head bones.

Fig. 17 (below). Fetus dead four days; no overlapping or asymmetry.

cessation of growth of the uterine tumor, loss of weight, and subjective symptoms of toxic absorption may add further evidence.

CONCLUSIONS

1. The history of cessation of fetal motion, absence of heart tones, a peculiar stillness on auscultation over the uterus, and a low basal metabolic rate are significant clinical data in establishing the diagnosis of intra-uterine fetal death.

2. Overlapping of cranial bones and asymmetry of the head have been observed by us in the live fetus to the same degree as in the dead. Therefore these signs are not pathognomonic of fetal death.

3. Collapse of the vertebral column in the dead fetus cannot be distinguished in the roentgenograms from apparent or illusory acute angulations of the spine in the live fetus.

4. The fetus may be dead certainly as long as four days and fail to show overlapping of cranial bones, or asymmetry of the head.

5. The roentgenographic diagnosis of intra-uterine fetal death cannot usually be made independent of other clinical data.

BIBLIOGRAPHY

Baer, J. L.: Basal metabolism in pregnancy and puerperium. Am. Jour. Obst. and Gynec., Sept., 1921, p. 249.

Bourland, J. W., and Spangler, Davis: The value of X-ray in obstetrics. Texas St. Jour. Med., Feb., 1925, XX, 560.

De Lee, Joseph B.: Principles and Practice of Obstetrics, fourth ed., W. B. Saunders Co., Philadelphia and London, 1924.

Doub, H. P.: Obstetrical roentgenology, with special reference to anencephaly. Am. Jour. Roentgenol. and Rad. Ther., July, 1925, XIV, 39.

Greenhill, J. P.: The value of X-ray in obstetrics. Med. Clin. No. Am., 1923, VII, No. 2, p. 611.

Horner, D. A.: Roentgenography in obstetrics. Surg., Gynec. and Obst., July, 1922, XXXV, 67.

Moss, M. N.: The X-ray in obstetrics. Minn. Med., Sept., 1924, p. 586.

Portes and Blanche: Le radio-diagnostic obstetrical. Gynec. et Obst., Paris, 1924, X, No. 5, p. 333.

Spalding, A. B.: A pathognomonic sign of intra-uterine death. Surg., Gynec. and Obst., June, 1922, XXXIV, 754.

Spangler, Davis: The value of the roentgen ray in the diagnosis of atypical pregnancies, with report of two cases of anencephaly diagnosed before birth. Am. Jour. Roentgenol. and Rad. Ther., March, 1924, p. 238.

Stein, Irving F., and Arens, Robert A.: The interpretation of early fetal roentgenograms. Radiology, Aug., 1924, p. 110.

Idem. Roentgenograms of the fetal skeleton as a positive sign of pregnancy. Jour. Am. Med. Assn., July 7, 1923, LXXXI, 4.

Werner, P.: Misleading roentgenography in twin pregnancy. Wien. klin. Wchnschr., Jan. 10, 1924, p. 32.

MENORRHAGIA AND METRORRHAGIA DUE TO CERTAIN BENIGN DISEASES OF THE UTERUS, AND THEIR TREATMENT BY IRRADIATION[1]

By HARRY H. BOWING, M.D., Section on Radium and Roentgen-ray Therapy, Mayo Clinic, Rochester, Minnesota

DURING 1915, the first fourteen patients with menorrhagia and metrorrhagia attributed to either genital or extragenital benign causes were treated with radium at the Mayo Clinic. The value of the method was soon appreciated. By the end of the sixth year, 923 patients had been treated and to date (September, 1925) a total of 2,060 patients have been treated. The accompanying chart shows this rapid rise and the fairly constant number of patients treated during the last seven years. The year is calculated from January 1 to December 31. The year 1925 is not closed, and, should the average be maintained, the total for the year will exceed that of the year 1924.

It is to be regretted that there are so few stations throughout the country where facilities for treatment with radium are adequate. A therapeutic agent so valuable and certain in its effects is deserving of a wider use. To-day every surgeon practising gynecology should be qualified to use radium and have at his disposal a sufficient supply of it for therapeutic purposes, or, better still, he should have associated with him competent consulting radiologists to supervise or give the treatments.

I am certain that those who are qualified to judge will admit there is no conflict between surgery and radiotherapy in the treatment of non-malignant menorrhagia and metrorrhagia. Both methods have their advantages and restrictions, and when these are understood the results obtained by the carefully selected method should be satisfactory.

[1]Presented before the Radiological Society of North America, at Cleveland, December 7-11, 1925. Read for the author by A. U. Desjardins, M.D.

To-day, it is not necessary for patient or surgeon to assume great operative risks in cases of benign uterine disease. When hemorrhage has caused marked anemia cautious

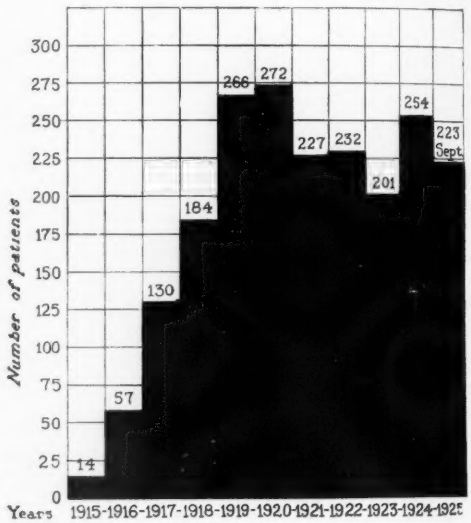


Chart showing the rapid rise in numbers of patients and the fairly constant number treated during the last seven years.

use of radium or roentgen rays will control the bleeding and give the patient time to overcome the anemia. Thus when operation proves necessary the primary surgical mortality is reduced, or if active radiotherapeutic measures are indicated at a later date, the patient is rendered more tolerant of them.

Conservative measures have been advocated by all competent operators in dealing with hemorrhage when due to benign pelvic disease, especially during the childbearing years. It is also exceedingly important to conserve ovarian tissue and thus prevent a stormy climacteric. According to most

opinions voiced to-day the use of radium is not a conservative procedure. Yet we know that the menopause brought on by the therapeutic administration of radium or roentgen rays is less stormy than that produced by castration.

The ideal dose should establish a temporary or, if necessary, a permanent amenorrhea. As yet, there are slight data to enable one to determine the dose necessary in a given case to produce the desired results. It is far better to undertreat—and repeat the treatment, if necessary.

There is an economic phase of the treatment that must not be overlooked. From this standpoint, radiotherapy cannot be excelled, as yet, by any other treatment. Treatment with radium requires only a few days in the hospital and no prolonged period of convalescence. Roentgenologic treatment as given to-day does not require admission to hospital, but, instead, many visits for the treatment. The patients living at great distances from the roentgenotherapist may find the expense entailed to be considerable.[2]

The indications for operation or treatment with radium or roentgen ray or for any combination of them are, in the main, definite, but at times selection may be very difficult.

A careful general physical examination is always essential, and its importance cannot be overemphasized. This is necessary for a full understanding of the case and a consideration of the best interests of the patient, for the advancement of knowledge of disease, and for tabulation, study and comparison of the advantages and limitations of the methods used. As soon as the general examination and laboratory analyses are completed and a diagnosis established the surgical and radiologic consultants should be asked for their opinion and advice. These preliminary and careful procedures should determine the best method to apply to each case.

Stacy discusses the indications for operative and radiologic treatment of various pelvic diseases. The following statements are of help in the selection of the method of treatment: "Pregnancy may occur after the application of radium, but in a small percentage of cases only."

"In young women with fibromyomas causing menorrhagia, radium should be used only in carefully selected cases and in small amounts in the initial treatment."

"Abdominal myomectomy is preferable to the use of radium in the treatment of women under thirty-five who have definite fibromyomas causing menorrhagia."

"Unless there is a definite contra-indication, I believe that large fibromyomas should be treated surgically because of the possibility that degenerative changes may occur in a tumor in which the blood supply has been interfered with, and because of the possibility of a mistaken diagnosis."

"Radium is the ideal treatment for menorrhagia in patients more than thirty-five who have a fibrous type of uterus, and for patients who have small fibromyomas and suffer from menorrhagia."

"In cases in which the history is suggestive of carcinoma of the fundus, abdominal hysterectomy is the safer procedure, and should be advised even if the diagnostic curettement reveals no malignant disease."

"A history or evidence of pelvic infection is a contra-indication to the use of radium."

The mental status of the individual is very important. Regardless of the severity of the climacteric phenomena present in a given case, as long as the mental attitude is clear and healthy, they do not contra-indicate the application of radium. However, in the case of the extremely anxious patient whose thoughts are scarcely rational and whose reaction to her surroundings is not normal, hasty treatment should not be insti-

[2]Since the advent of treatment by roentgen rays of high voltage, patients have been treated by one exposure, and the necessity for repeated treatments may thus be obviated.

tuted. It is, rather, better to defer treatment until it is absolutely necessary, than to try to convince the patient that she is in need of the treatment. One should be constantly on the lookout for such patients, for I am sure their mental state is not improved by radium treatment. There are a few patients who, in spite of these conservative methods, have failed to respond. When medical and minor surgical procedures have failed, small doses of radium may be tried. When one small dose of radium has failed, further small doses should be considered. A sufficient interval should elapse between procedures in order to allow sufficient time to prove that all the benefit possible has accrued and that further treatment is necessary. This interval is usually a matter of months.

It is my practice to insert radium directly into the uterine cavity in all cases and to give supplementary roentgenologic treatment when the uterine mass is beyond the size of the uterus at the fifth or sixth month of pregnancy. As a rule, one radium treatment, or one application of radium with one roentgen-ray treatment (as indicated) is all that is necessary to bring about partial or complete cessation of menstruation.

The effect of the therapeutic rays is direct and indirect and, accordingly, exceedingly complex. The cellular elements of the tumors are known to be affected directly. The function of the follicular portion of the ovary is temporarily or permanently inhibited, and thus menstruation is partially or completely checked. The tumor is thus robbed of its blood supply, either by the cessation of the monthly engorgement or by the direct interruption of the circulation. The endometrium directly in contact with the radium tube is destroyed and replaced by fibrous tissue, so that the amount of the bleeding endometrial surface is reduced. The glandular elements in the layers of the uterus undergo a certain amount of atrophy and become less active. The endothelial elements are very sensitive to the rays, and, as a result, the smaller blood vessels and lymphatic channels are occluded.

TECHNIC FOR THE USE OF RADIUM

The radium applicator ordinarily used is the universal silver tube applicator (walls 0.5 mm. thick), containing 50 mg. of radium element (sulphate). From one to three tubes may be used in a given case. The filters are brass, 1 mm. thick, and Para rubber, 1 or 2 mm. thick. The dose may be considered as small, moderate, or large. The small dose is usually 200 to 300 mg. hours, only Para rubber being employed as an added filter. A moderate dose varies from 300 to 600 mg. hours. In such cases only Para rubber is employed as added filter, although when ultra-conservative methods are indicated, 1 mm. of brass for additional filtration is indicated. The large dose is the menopause dose and varies from 700 to 1,200 mg. hours. For doses of from 700 to 800 mg. hours, Para rubber as an added filter may be used. For larger doses filtration through 1 mm. of brass and Para rubber is indicated.

In cases in which dilatation or curettement is indicated, radium may be inserted at the time of the operation or four to six days later. The delay has much to commend it, chiefly the opportunity to establish the fact that the surgical manipulation has not lighted up an old pelvic inflammation.

In inserting radium one should follow a thorough surgical technic. The dilatation for inserting the applicator should be minimal, for all unnecessary trauma should be avoided and the dissemination of infection thus minimized.

I have found that a hypodermic injection of 1/300 grain of scopolamin hydrobromid, and 1/6 grain of morphin sulphate, twenty

minutes before the introduction of radium, makes the necessary dilatation painless and keeps the patient comfortable during the application.

It has been necessary to institute treatment in a few cases in which there were a definite history and findings of old pelvic inflammation; in these, only filtered rays were employed. The vaginal package, containing the universal silver tube applicator, 50 mg. of radium element (sulphate) filtered through the wall of the applicator (0.5 mm. of silver), 1.0 mm. of brass, 7.0 mm. of Para rubber, the wall of the vaginal package, may be placed in each vaginal fornix for periods of ten hours. When the applicator is being inserted the knee-chest position is employed. The distended vaginal cavity is then tamped tightly with gauze packing (moistened, 2-inch gauze bandage). The surface of the abdomen overlying the uterine enlargement is packed with radium surface-packs. This portion of the abdomen is mapped off into areas measuring 4 cm. square. The universal silver tube previously described is applied to each area, but is maintained at a distance of 2.5 cm. by the interposition of a balsa wood block, the base of which measures 3 by 4 cm. The added filtration is accomplished by 2 mm. of lead and 2 mm. of Para rubber. The time is from fourteen to twenty hours for each area. In the few cases in which this type of treatment has been employed, no complications have as yet occurred.

TECHNIC FOR THE USE OF ROENTGEN RAYS

When the radium treatment is supplemented by roentgenologic treatment, the following dose factors are employed: kilovolts 200; filtration, 0.75 mm. copper and 2.0 mm. aluminium; distance, 50 cm.; current, 5 milliamperes, one hour for each area; areas, one anterior abdominal, and one posterior; size of area, 20 by 20 cm.

When the uterus is as large as in a pregnancy of five or six months, fibromyomas require only one treatment. However, should the fibromyoma be of greater size, so that the uterus is as large as that of a pregnancy of from five to seven months' duration, the treatment may be repeated. Should amenorrhea occur, I question the value of further treatment. As yet we have no data on which to base an opinion as to whether the tumor is made to diminish more rapidly by further treatment.

RESULTS

The results, in the main, are satisfactory and have stood the test of time. If the cases had been unwisely selected and if the initial as well as the final result had been unsatisfactory, the popularity of this therapeutic agent would have vanished.

When small and moderate doses of radium are used it may be necessary to repeat them from time to time. An interval of several months should elapse between treatments. In a few cases where 1,000 or 1,200 mg. hours have been used, it may be necessary to repeat the treatment, but operative treatment may be indicated owing to the possibility of a mistaken diagnosis. Provided the risk is not great, an operation is better than repeated applications of radium.

The result may occur immediately, or after an interval of six or eight weeks. In some, a gradual lessening of the quantity of the flow is noted. A few patients report an excessive flow at the period following the application of radium. The patient should be informed of these possibilities so that her anxiety may be relieved. She should also be instructed regarding the climacteric phenomena, and symptomatic treatment should be prescribed when necessary. When large fibromyomas are present many months are required for their reduction.

CONCLUSIONS

1. A thorough clinical examination, operative treatment and irradiation play a def-

inite and distinct rôle in the diagnosis and treatment of menorrhagia and metrorrhagia due to benign diseases.

2. When radium is available and can be applied directly to the uterine walls by way of the uterine canal it is the method of choice; it should be supplemented with roentgen-ray treatment when the fundus is larger than in a pregnancy of five or six months' duration. When radium is not available, roentgen rays used alone are effective, and, as a rule, must be repeatedly applied for some months.

BIBLIOGRAPHY

1. Stacy, Leda J.: Results of myomectomy. St. Paul Med. Jour., 1916, XVIII, 344-345.
2. Stacy, Leda J.: The treatment of menorrhagia with radium. Minn. Med., 1919, II, 88-91.
3. Stacy, Leda J.: Radium treatment in 600 cases of menorrhagia. Am. Jour. Roentgenol., 1920, VII, 379-382.
4. Stacy, Leda J.: The treatment of uterine tumors. Jour. Iowa State Med. Soc., 1920, X, 301-303.
5. Stacy, Leda J.: The treatment of benign conditions of the pelvis with radium. Am. Jour. Roentgenol. and Rad. Ther., 1922, IX, 658-662.

DISCUSSION

Dr. L. R. Sante (St. Louis): In discussing Dr. Bowing's paper, I think that all of us are so conversant with the applicability of radium in malignancy of the pelvic organs, especially carcinoma of the cervix, that we are apt to forget its applicability to and its great usefulness in some benign lesions. For instance, in endocervicitis and endometritis. In these conditions we have found the application of relatively small doses of radium to be highly efficacious. Many conditions respond equally well to X-ray or radium, and we are always confronted by the necessity for decision between these two agents. I think that—at least, in our practice—it is divided something like this: If you want your effect locally—I mean by that, very superficially in the uterus, for control of bleeding from endometritis or for the cleaning up of an infection in endocervicitis or for effect upon a very superficial submucous fibroid—radium application is your method of choice; whereas, if you are dealing with a large intramural fibroid, X-ray—it seems to me—is the only agent required, and the logical choice. As Dr. Desjardins read in Dr. Bowing's paper, the long-continued exposure to X-rays for control of bleeding from fibroids is no longer the rule. A single exposure, or, at the most, two or three exposures, is all that is required.

We have used twilight sleep anesthesia, such as Dr. Bowing referred to, and we have found that this is a most desirable anesthesia. I can hardly call it rightly an anesthesia; rather, it is a blunting of the sensibilities of the patient. We use it in all our radium applications, not only those that require dilatation of the cervix, but also in the implantation of radium seeds in carcinoma of the tongue, tonsils, etc. Twilight sleep anesthesia seems to be highly efficacious.

There is one point I want to make in speaking of the handling of pelvic cases, more particularly by the radiologist. Dr. Bowing has said that every surgeon should have access to and *be able to use radium.* I do not agree with him. It is my opinion and conviction that the control of the armamentarium of the radiologist should be in the hands of one man or one group of men. Such a man may be a surgeon or he may be a radiologist, but to develop any sort of useful technic with these very powerful agents —powerful for ill as well as for good—they must be in the hands and under the control of one man, or a group of men working in a certain community. They should not be in the hands of every surgeon. I will take a moment to illustrate the necessity for unity in control of cancer cases. When we started our work with carcinoma of the cervix,

we began with the introduction of tandem tubes: I mean two tubes together, one extending into the uterine cavity and the other into the cervix. Many little points enter into the application of radium which require an intimate knowledge, by the individual using it, of its biological effects and its physical properties, and even a simple application presents many possibilities—the matter of filtration, the various biological effects of the various types of radiation, and so on. It is the falling into these difficulties and getting out of them which really constitutes experience. If the tube inserted in the cervix is too strong and the dosage too great, and the one extending into the uterus produces too small a dose, you may have defeated your purpose in that you may have caused a constriction of the cervix and not influenced the mucous membrane behind. In this way a dysmenorrhea may be developed which is even worse than before. Many little things like this enter into the question. We found that, using tubes in the cervix only, we were not getting sufficient radiation, and adopted the method of including, besides, the application of radium in a large lead block with a rectangular opening, held in three positions—right, middle and left—in order to sweep the pelvis from side to side. Now it would seem that any ordinary kind of block, so long as it had enough lead around it and a deep enough hole in it, would be all right for the application of this method; but if you will inquire into the matter a little more closely and see the dosage curves that are plotted out by physicists in various types of "bomb" construction where the distance of the radium from the surface of the bone varies and where the size of the opening varies in relation to its depth, you will see that a great deal of difference will result in the ultimate amount of radiation you deliver. The very fact that the opening should be oblong, with its longest dimension from side to side so as to sweep the pelvis in a horizontal direction, thereby guarding against over-radiation of bladder and rectum, can do much to alleviate bladder and rectal symptoms in such cases. One other small point that came to our attention: We used as a filter two millimeters of brass over the end of the "bomb." The filter came to the very edge of it. Six or eight weeks after an exposure we noted an atresia of the vagina, and could not figure out at first what its cause might be. After careful analysis of the method of treatment we concluded that the secondary radiation from the brass filter, coming in intimate contact with the vagina in a perfectly round ring, was the thing that was causing the atresia. Cutting down the size of the disc and inserting it in the end of the lead quickly overcame that difficulty. These are only a few of the many instances; only men familiar with their physical properties and working with them all of the time should handle these very powerful agents.

DR. W. E. CHAMBERLAIN (San Francisco): In regard to the roentgen diagnosis of intra-uterine fetal death, I am surprised that Dr. Stein and Dr. Arens have arrived at such different conclusions from those of Spalding and Horner.

In order that a sign may be called pathognomonic, it is not necessary that it shall be present in every case. It is only necessary that whenever the sign is present the condition be present. In our series at Stanford there have been cases of fetal death in which delivery occurred before the X-ray appearance became characteristic, but whenever the characteristic cranial shrinkage was demonstrated, a dead fetus was subsequently proven.

I had forgotten that Dr. Spalding's paper reported only three cases. These have been added to by a considerable number since his publication.

It will always be difficult to describe what

we consider the characteristic roentgenological appearance of fetal death. Overlapping of the cranial bones occurs almost universally while the fetal head is in the birth canal. It is necessary to distinguish carefully this common type of overlapping from the deformity which we have observed in cases of fetal death.

The deformity which is characteristic of fetal death consists in a reduction of the area of the head shadow (shrinkage of volume of head) without any accompanying change in the shape of the individual bones. In other words, the total area of the head shadow is less than the curvature of the individual cranial bones would lead one to expect. In a live fetus, the overlapping of cranial bones occurs without this disparity, *i.e.*, without any shrinkage of the volume of the head. It must be admitted that the making of this differentiation (between molding in the live fetus and shrinkage in the dead) is not easy. If we are to avoid calling many live fetuses dead, we must draw the conclusion "dead fetus" only when we are satisfied that the head shows an actual shrinkage.

For obvious reasons, shrinkage will not become demonstrable until some time has elapsed after fetal death. In our experience, shrinkage sufficient for X-ray demonstration may occur at about three days, but has once or twice taken ten days to develop.

We do not feel that the location of the head, whether within the birth canal or floating in the abdomen, makes any difference in the diagnosis. In other words, it is not a question of looking for a change in the size of the head, and the shape of the individual cranial bones is our criterion.

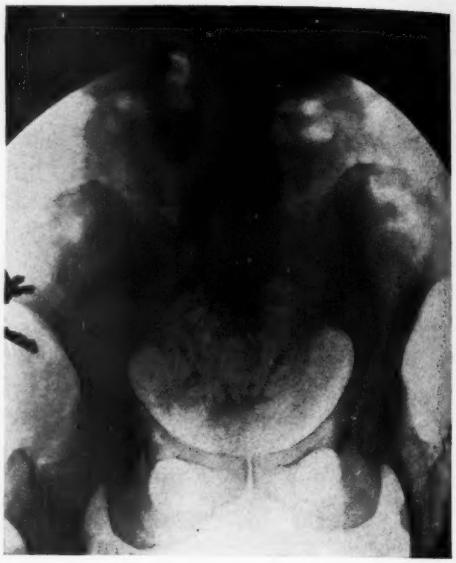


Fig. 1. Film exhibited by Dr. John S. Derr, accompanying discussion.

Dr. J. S. Derr (Atlanta, Ga.): I think this film (Fig. 1) shows the sign of the contraction of the skull that has been described. A five-months pregnancy, no sign of life for two weeks. The total dimensions of the cranium are diminished. Comparing it with other cases of pregnancy which I have seen, there was no doubt in my mind when I saw the film that the fetus was dead. The woman had had intermittent uterine contraction and the abdomen was firm, but there was very little evidence of toxic absorption. The whole appearance of the fetus seemed to indicate that it was macerated, the ribs pressed together and the bones of the cranium overlapped. The patient aborted spontaneously after the cervix was packed.

Dr. R. A. Arens (Chicago): The finding of overriding cranial bones is something we have frequently found in the normal fetus. It simply comes down to a question of this: We admit that overriding may occur with cranial shrinkage and maceration, but at such a time as it is no longer practical to make that interpretation so as to be of value to the clinician, and, secondly, that we can and have shown it. We will

be very glad if Dr. Chamberlain will stop on his way to the coast and inspect our films for direct comparison with his work. I personally was very loath to give out the report that this sign could not be relied upon, but let the facts speak for themselves.

DR. STEIN (closing): I am exceedingly grateful to the members for this discussion. I feel that this subject is one a little off the beaten path of the roentgenologist, and still it is met with occasionally. I think I am going to have Dr. Arens stop off in California and take a few lessons from Dr. Chamberlain and Dr. Spalding, because, if they have been able to diagnose fetal death in twelve consecutive cases and Dr. Arens has been picking out some of our live fetuses showing typical signs, there must be something wrong. However, we have had a very interesting time in getting this material together because we took the cases that showed overlapping or asymmetry, fetal collapse or angulation, anything that might suggest fetal death, and we did not select them in any other way than from the roentgen interpretation. Then we tried to pick out the dead fetuses and we were "up against it." We went at it purely from the objective standpoint and we think we have been exceedingly fair about it. We did not want to "knock" anyone; we wanted to start just such a discussion as we have had, and I am glad you have taken interest in such a discussion. The question of whether the head is engaged or not is a vital question, but that is *clinical*. If the report comes to the roentgenologist that this patient is in the first stage of labor or the head is engaged, he is going to evaluate the overlapping of the head bones and their asymmetry. If he does not know whether that head is engaged or not, he is going to be "up against it." I agree with Dr. Chamberlain that if the sign does not show, it does not mean that it has no value, but if you know that the head is floating, the patient is not in labor and the fetal head shows marked asymmetry and overriding, the sign is of much more value than if the woman has had a number of hours of labor.

The question that Dr. Richards brought up about endometritis,—I hardly think we can ascribe any such effect to the X-ray used for roentgenography. If you can safely subject a newborn baby to exposure for treatment without producing inflammation in the internal organs, I think that we need not consider that question very seriously. Last month at the roentgenologic meeting in Chicago, Dr. Lee asked a similar question about a case that had apparently developed peritonitis after cesarean section, and an X-ray film had been taken before. I believe that ascribing any blame to the X-ray is rather "far-fetched."

RADIO-ACTIVE SUBSTANCES: THEIR THERAPEUTIC USES AND APPLICATIONS

RADIUM TREATMENT OF PATHOLOGIC CONDITIONS OF THE TONSIL

By JOSEPH MUIR, M.D., New York City

ALTHOUGH it is not probable that any one has ever counted the number of words which have been written concerning the tonsil and the pathologic conditions to which it is itself liable, and which it is capable of imposing upon other parts of the organism, there is no doubt that the mass of literature on this subject is one of the most stupendous in the annals of medical writing. It is practically impossible for any one person to familiarize himself with even the most important part of it. Moreover, in view of the fact that we have never arrived at any very definite conclusions regarding the treatment of tonsil pathology, and that every phase of the matter is still a source of bitter controversy among those who have devoted their lives to a study of this relatively insignificant portion of our bodies, the contemplation of all these literary efforts to elucidate a still obscure subject, has a distinctly saddening effect. The history of tonsil treatment seems to be largely a history of medical fads, of efforts early aborted in most instances, to "think up something new," of eager certainty that the long-sought goal had at last been reached, only too soon followed by the overwhelming conviction that the *ignis fatuus* has once more eluded us.

Therefore, to put forward a "new" treatment for disease of the tonsil demands considerable temerity, and those to whom this innovation is offered can hardly be blamed if they are inclined to be skeptical of its merits upon first consideration. It is only when a therapeutic procedure is the logical outcome of those which have been productive of good results in the past that it is entitled to consideration, and such consideration can be expected only after its own worth has been fully demonstrated.

Radiation of the tonsils cannot justly be regarded, however, as a "new" procedure, for it is at least ten years since the peculiar suitability of a lymphoid structure for such treatment occurred to those who were concerning themselves with the therapeutic application of radio-activity. Histologically, the tonsil is almost wholly a lymphoid tissue lying upon a layer of reticular tissue and enclosed by endodermal epithelium. Under its epithelial basement membrane is situated a very vascular connective tissue which forms its protective capsule. The epithelium is much stratified, the cells upon its free surface having a flattened appearance under the microscope, while beneath they are seen to be columnar. The epithelial surface of the tonsil is full of crypts, the linings of which are continuous with the rest of the epithelial covering (Fig. 1). Everywhere lymphocytes are in evidence among the epithelial cells, in some areas being so numerous as to give the surface an appearance resembling disintegration. Lymph nodules can be made out about the crypts in the reticular layer of the epithelium, and in some of these nodules it is possible to distinguish germinative centers, though this is by no means a universal finding. Some time ago, Bergondie and Trebandeau, in studying the biological effects of radiation, found that the less definite the morphology and function of a cell, the greater will be its radiosensitivity, and also that this radiosensitivity will likewise be more marked in proportion to its reproductive activity and the duration of karyokinesis.

When we consider the lymphoid structure of the tonsil, and if we accept the findings of the French investigators just cited, it immediately appears odd that radio-activity should have been therapeutically available for so long a time before it occurred to any one to apply it to the tonsil, especially for the reduction of the very common condition of chronic hypertrophy. Yet it was not until 1920 that any concerted effort to apply radiation to hypertrophied tonsils was made, and only in the past year or two that sufficient data have been accumulated to enable us to arrive at any even relatively accurate estimate of its value in this connection. In the year named, the Rockefeller Institute made extensive investigations of the effect of roentgen-ray exposure upon hypertrophied tonsils, and later, the chief investigator, W. D. Witherbee, continued the work by himself, finally succeeding in establishing a relatively exact technic, and providing the medical profession with much valuable information concerning the behavior of the tonsil when subjected to radiotherapy.

It soon became apparent, however, that although the results of roentgenotherapy of the tonsil were excellent in many cases, there remained a number of very definite drawbacks to the method. Though it avoided the trauma inseparable from surgical removal, the lymphoid masses frequently remained more or less in evidence, and it was not long before observers whose opinion is not usually lightly expressed declared that upon some patients the X-ray treatments had no effect whatsoever. Last year James W. Babcock collected the arguments for and against radiation in the treatment of tonsillar hypertrophy. His paper is very interesting reading. In all, he reviewed 49 articles, 28 of which were heartily in favor of radiotherapy, 11 stated that the authors found it of limited but still distinct value, while 10, or 20 per cent, proclaimed it of little or no use. Twenty per cent is a sufficiently sizable minority to deserve consideration, and an analysis of the reasons put forward to support these objections does not throw much light upon the position of those

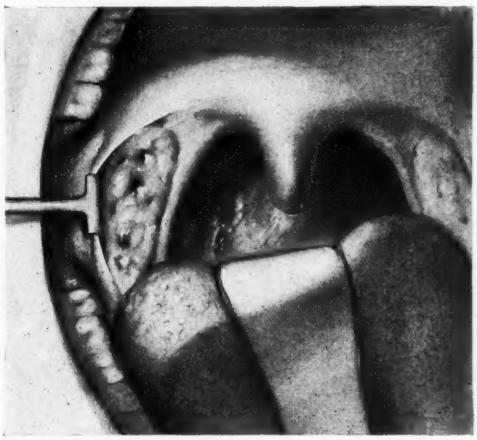


Fig. 1. "The epithelial surface of the tonsil is full of crypts, the linings of which are continuous with the rest of the epithelial covering."

who made them. Babcock says: "The freeing of the tonsils from pathogenic bacteria is not accepted by all. Ullmann and Nuzum, in a series of 218 pairs of irradiated tonsils, found hemolytic organisms in 96.1 per cent; a year earlier, Nuzum reported that X-ray therapy was effective in reducing the size of the tonsils in 16 per cent of his cases, and hemolytic streptococci were permanently removed in but 50 per cent. The method of freeing the tonsils of bacteria by widening the crypts was not shown in the cases reported by the author. As for benefit to associated lesions, Shurly states that unless the tonsil can be sterilized it remains a menace to the system. Lederer finds that in no case were many marked changes observed, and only in children with typical hypertrophied tonsils was even a slight change in size observed. Patients with chronic tonsillitis were benefited for a time, only to have recurrence. Waters, MacCready and Hitchcock state that there is no evidence that

reduction in the size of the tonsils by irradiation is accompanied by eradication of the carrier state in individuals harboring the hemolytic streptococcus in these tonsils.

It was stated in discussion at the annual meeting of the American Radium Society two years ago, that the first man to suggest radium or roentgen-ray treatment of the tonsils was William L. Ross, of Omaha, Nebraska. If this be true, Dr. Ross has certainly been robbed of the credit due him, and a restatement of the facts is in order. It seems to be generally conceded that radium treatment was first applied to the tonsils by Francis H. Williams, of Boston, who published a paper on "Treatment of Hypertrophied Tonsils and Adenoids by Radium" in March, 1921, and has several times since made public his progress along these lines. It was apparent to him, as it speedily became to many others, that in radium we have an agent with all the therapeutic possibilities and advantages over surgery possessed by the roentgen rays, that is, at the same time far more flexible and adjustable, and capable of being so handled as to place the radiation in locations hitherto inaccessible to anything but the knife.

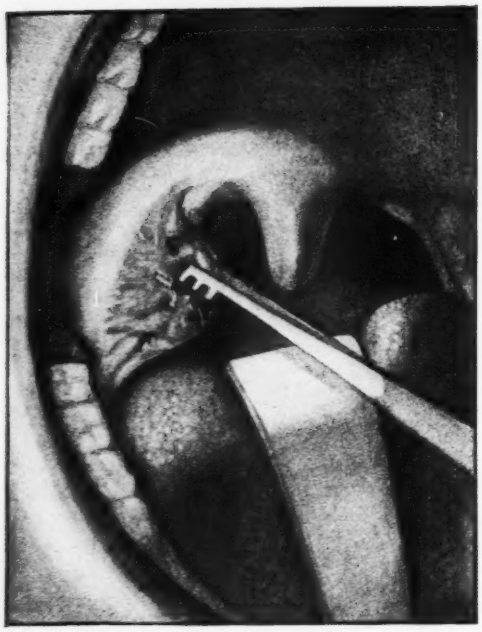


Fig. 2. "As soon as the radium has done its work the seed can be removed with no discomfort to the patient."

A number of different methods of applying radium to the hypertrophied tonsil have been followed in the past five years, among which may be enumerated: Direct application of radium element in screened containers; the application of screened radium element upon the outside of the neck over the tonsil; direct application of a radium plaque, and finally the insertion of needles or the implantation of bare tubes of radium emanation. The advantage particularly stressed by the earlier workers that radium possesses over X-ray lies in the fact that the fear engendered by the X-ray apparatus often made little children very difficult patients to handle, and the necessity of making many exposures with considerable lapse of time between such treatments, made the whole course tedious and expensive of both money and patience.

The employment of radium obviated these objections to radiotherapy. The radium applicators were silent and non-terrifying, and fewer treatments sufficed to accomplish the desired result; in fact, it was not long before it was realized that one, or, at the most, two, applications, would be ample in even the most obstinate cases. Simpson, of Washington, has reported extensively upon his results with plaques, needles and seeds. He claims that all the cases of tonsillar hypertrophy previously treated by roentgenotherapy which he has encountered "show on examination definite masses of lymphatic tissue in the tonsillar fossa. The results of such treatment do not compare favorably with the results following the application of radium directly on or into the tonsil. We must clear the fossa of lymphatic tissue if

we hope to get deserved recognition from the laryngologists, and the best clinical and bacteriological results." He has found that one application of an oval plaque containing something less than 30 mg. of radium element, held directly against the tonsil for thirty minutes, is more effective, and diminishes the size of the gland quite as much as four or five roentgen treatments. When he has implanted bare tubes or seeds he at first has had some severe reactions with much pain, but by employing very small dosage in each radio-active center these unpleasant sequelæ have been largely eliminated. Though he now has occasional "sore throat," in most patients this can be avoided, and "in many cases one treatment causes the tonsil to vanish."

The needle method is favorably reported upon by C. F. Robinson. He uses two 12.5 mgm. needles, which are threaded and introduced into the center of the tonsil, where they are left in place for from two to four hours. Both tonsils can be done at the same time, and in from four to six weeks complete atrophy will have taken place, "the anterior pillar having to be retracted in order to find any remaining tonsil." Withers prefers the use of bare tubes, mentioning that the reaction is not painful and is confined to the depths of the tonsil, which does not interfere with swallowing, so that the patient is more comfortable during the radium reaction than with the use of either needles or plaques.

It is evident that entire avoidance of reaction would be still more desirable, and it is therefore gratifying to be able to bring forward a method whereby all unpleasant sequelæ are avoided, while at the same time the efficiency and simplicity of the treatment are in no wise diminished. Implantation of a single platinum radon seed in the center of the hypertrophied tonsil is usually sufficient to bring about complete reduction of the lymphoid mass within a few days, and as soon as the radium has done its work the seed can be removed with no discomfort to the patient (Fig. 2). The platinum filtration prevents the production of necrosis by the caustic beta rays, as these are cut off by the filter. A four-day exposure from a 2.5 millicurie seed is amply sufficient to bring about the desired result, and the entire treatment is so easily carried out, and so perfectly free from danger and discomfort as to be a revelation to those previously unfamiliar with it.

Though implantation for tonsillar hypertrophy is generally carried out intraorally, it is possible, if for any reason it seems desirable, to place the seeds from the outside. In treating malignancy of the tonsil this is, in most cases, the method to be preferred. When we are dealing with malignancy there are a number of factors to be considered which do not enter into the simpler problem of getting rid of redundant but benign tissue structures. Not the least important of these is the very great probability of cervical metastasis.

Malignant disease of the tonsil is usually regarded as of rare occurrence, and the majority of recorded cases seem to be sarcomatous in nature rather than the epithelial carcinoma which is the more frequently occurring malignant neoplasm in other parts of the oral cavity. As a matter of fact it may appear later, after more careful histological differentiation has been practised long enough to make accurate statistics available, that this difference is more apparent than real, and that many questionable conditions occurring in the tonsil are in reality carcinoma. The diagnosis of these growths has always been attended with considerable difficulty, and although the position which they occupy so soon causes inconvenience and pain to the patient that he is early moved to seek medical advice, their true nature so frequently goes unrecognized that the right treatment is not often applied

early enough to be of any avail. Many a diagnosis of quinsy, of syphilis, or tuberculosis has served to divert attention from the malignant nature of the disease until too late. Any obstinate throat lesion which refuses to yield to ordinary treatment should be looked upon with suspicion, and even when the routine tests point in the direction of lues or tuberculosis, the clinician must be very sure of his ground before positively ruling out malignancy. The age of the patient should be taken into account; sarcomatous throat lesions are most likely to appear in the second and third decades of life; after forty-five epithelioma would be more probable. All malignancies of the tonsil are extremely grave lesions, and only a guarded prognosis should be given except where treatment has been instituted very early.

Recent literature regarding tonsillar malignancy is decidedly scanty. As far back as 1908, Freudenthal treated a case of sarcoma with radium, and in the few reports made in recent years various forms of radium treatment have been advocated and described. Despite the generally accepted rarity of tonsil malignancy, almost a hundred and fifty such cases were treated at the Memorial Hospital during a five-year period. Many of these were recurrences after surgical removal of the original growth.

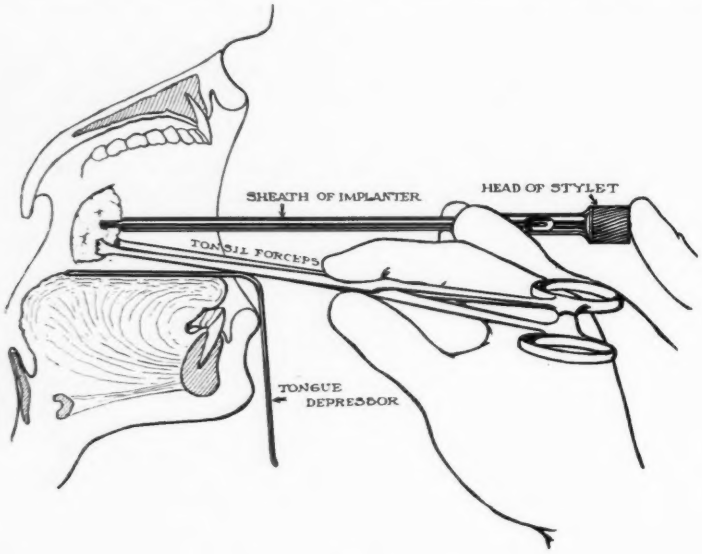


Fig. 3.

Since 1917 such growths have been treated at this institution by means of bare capillary tubes of radium emanation buried in the tonsillar tissue. Such a method is possible only when very small amounts of radiation are placed in the tubes, for large dosage induces so much necrosis in the highly susceptible lymphoid tissue that blood vessels are liable to be involved, entailing serious or even fatal hemorrhage. The cervical metastases are handled by X-ray applications and the placing of a heavily filtered radium tray externally over the tonsillar region. If a definitely enlarged node is present in the neck, the radium tray is used over this as well.

The records of the New York State Institute for the Study of Malignant Disease also indicate that tonsil cancer is more common than we have hitherto believed, for out of three thousand patients treated there, forty-

five were proved by biopsy to have epithelioma of the tonsil; sarcomata were excluded from this series. In the earlier work done at this institute X-ray was used on tonsil cases, but the results were not very satisfactory. For the past four or five years they have been using buried radium emanation for the primary growth and deep X-ray combined with radium packs for the metastatic areas. It is the opinion of Leon H. Smith, who reported the Buffalo institution's work, that deep X-ray causes less untoward reaction than radium in the presence of secondary infection.

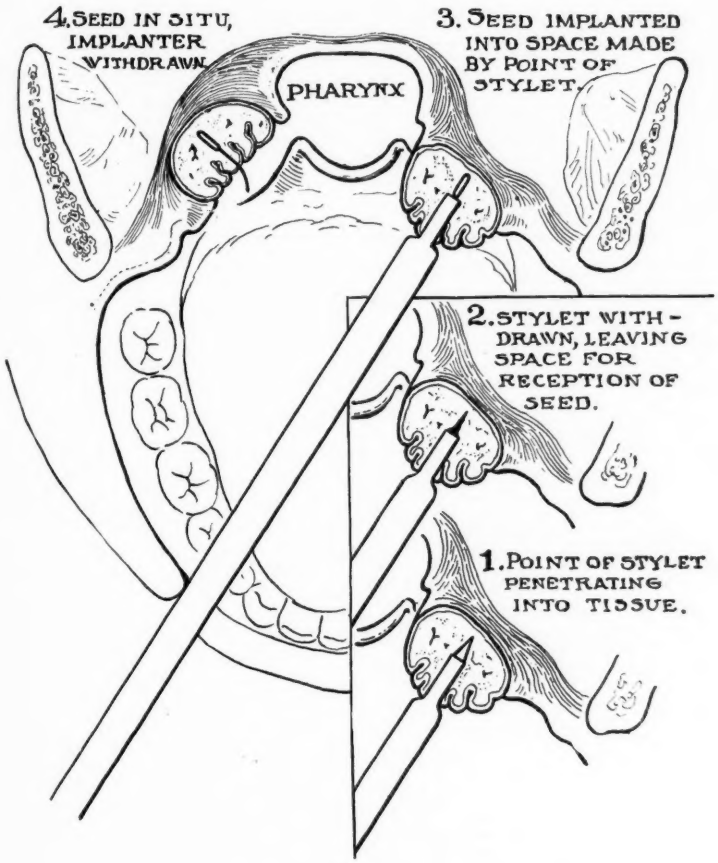

4. SEED IN SITU, IMPLANTER WITHDRAWN
3. SEED IMPLANTED INTO SPACE MADE BY POINT OF STYLET.
PHARYNX
2. STYLET WITHDRAWN, LEAVING SPACE FOR RECEPTION OF SEED.
1. POINT OF STYLET PENETRATING INTO TISSUE.

Fig. 4.

The chief point in the therapy of such a growth as that commonly found in the tonsil, when radiation is to be the agent employed, is that the radiation should be adequate, not only to reach all actively malignant tissue but to extend to what the French term the *zone d'ensemencement latente*, that is, the tissues encircling the visibly malignant area which are potentially, if not actually, involved in the neoplastic process. The most satisfactory means of accomplishing this so far has been the implantation of small centers of radio-activity, placed at intervals about the periphery of the growth, as well as through the center. The problem here is exactly the reverse of that offered in

benign hypertrophy. In the enlarged tonsil we must reach the center primarily, as that is the point where cell multiplication is going on most rapidly; in the malignant tonsil, the aim must be to prevent extension from the periphery—if the cells upon the outer limits are inhibited and sterilized they will form a barrier sufficient to prevent further activity extending from within.

With the seeds adequately filtered, invasion of the blood vessels by a necrotic process is no longer to be feared, and we are enabled to put in as many radio-active centers as the size of the lesion indicates, without taking thought of damage to surrounding tissues, which made the old bare tube method so hazardous when used about the throat. Careful preliminary palpation will determine the extent and depth of the lesion, so that the seeds can be placed far enough down to reach all involved tissue with the therapeutic gamma rays.

When such a tonsil lesion is seen early enough to apply this treatment before cervical metastases have taken place, the chances of complete eradication are very good indeed, and though we must never lose sight of the high degree of malignancy which is inherent in most neoplasms of the buccal cavity, we feel justified in offering this therapy as the most thorough and comprehensive which has yet been placed at the disposal of clinicians.

REFERENCES

BABCOCK, J. W.: A review of radiotherapy for chronic tonsillitis. Ann. Otol., Rhinol. and Laryngol., 34: 834, 1925.

QUICK, DOUGLAS: Treatment of malignant neoplasm of the tonsils. Jour. Radiol., 3: 173, 1922.

ROBINSON, C. F.: Radium treatment of diseased tonsils. Am. Jour. Roentgenol., 9: 588, 1922.

ROSS, MARTIN: Squamous-cell carcinoma of the tonsil. Laryngoscope, 35; 15, 1925.

SHURLY, B. R.: The removal of tonsils with special reference to methods other than complete enucleation. Jour. Am. Med. Assn., 81: 800, Sept. 8, 1923.

SIMPSON, C. A.: Radium treatment of tonsils. Am. Jour. Roentgenol. and Rad. Ther., 12: 527, 1924.

SMITH, L. H.: Epithelioma of the tonsil. N. Y. St. Jour. Med., 24: 289, 1924.

WELLS, W. A.: On the use of radium to induce atrophy in the faucial tonsils—histologic evidence. Laryngoscope, 33: 681, 1923.

WILLIAMS, F. H.: The use of radium radiations in the treatment of tonsils. Am. Jour. Med. Sci., 168: 18, July, 1924.

WITHERS, S.: On the use of radium to effect an atrophy of pharyngeal lymphoid tissue. Laryngoscope, 32: 163, March, 1922.

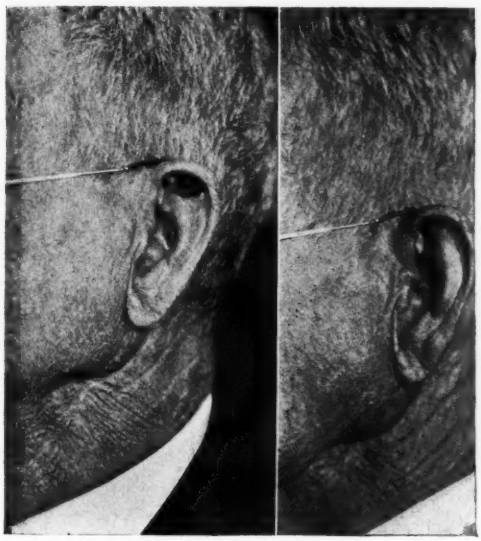
RADIUM TREATMENT OF EPITHELIOMA OF THE EAR

By WILLIAM H. KENNEDY, M.D., Indianapolis, Indiana

IMPORTANT as is the institution of proper treatment of epithelioma of the auditory organ, its early and proper diagnosis must be regarded as an equally essential factor in contributing to a satisfactory outcome.

A knowledge of the structure and natural course of tumors, beyond doubt, constitutes the basis of diagnosis in these cases; likewise, a recognition of the pre-cancerous state is indispensable. In addition, much valuable service may be rendered by microscopic examination of a portion of the tumor and by such pathologic analyses as may be indicated from a general physical examination. On the whole, the closest co-operation between pathologist and clinician is demanded to meet the requirements of the diagnostic situation.

The etiology of all carcinomata being still undetermined, a study of the predisposing factors of the lesion under present consideration demands attention. Primarily these factors are the same as for epitheliomata of other parts of the head, namely, warts, moles, pigmented nevi, and the keratoses of old age; irritation and injury; climatic conditions such as the sun's rays, freezing, etc.; heredity. In this location, epithelioma often follows a chronic suppurative condition of the ear, or a mastoid. It is more frequent in the male than in the female sex; its occurrence in persons less than fifty-five years of age is unusual. Broders (1), in a report of sixty-three cases of epithelioma of the ear, reports sixty-one and one-quarter years as the average age in his series. Females comprised 23.8 per cent, males 76.19 per cent of the group. A point of unusual interest is found in his statement that, of the males in this series, 64.44 per cent were farmers. Those having a history of previous wart, mole, scab, keratosis, ulcer, eczema, pimple or lump at the site of the lesion formed 63.49 per cent; injury or infection, 19.94 per cent. Likewise, 19.04 per cent of the subjects gave a family history of malignancy.

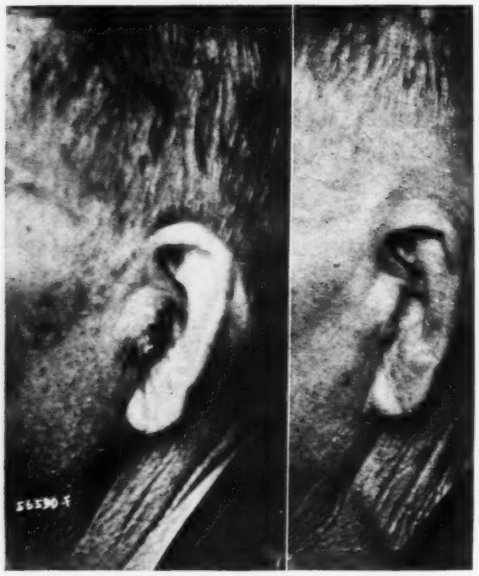


Figs. 1 and 2. Epithelioma of fossa of the helix; same case after radium treatment.

Epitheliomata of the ear comprise only a small percentage of lesions about the head. Although this fact no doubt accounts for the dearth of literature on this special subject—the condition usually being included among general articles on neoplastic conditions of the head—a study of epithelioma of the ear is no less important than is epithelioma of the lip, for instance, to which much attention has been devoted. Based on the writer's own experience, however, the occurrence of epitheliomata of the ear seems at present to be growing more frequent. This apparent increase in the number of cases presented for radium treatment may be attributed in all probability to a growing

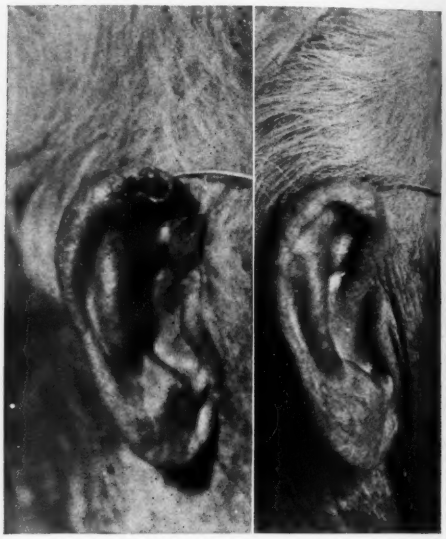
preference on the part of the profession in general, for this particular form of therapy.

Epitheliomata may be divided histologically into three main types: *(a)* basal-cell epithelioma (rodent ulcer); *(b)* squamous-cell epithelioma, and *(c)* melanosarcoma, the first being the least malignant form, the squamous-cell type next, the melanosarcoma being most malignant of the three. Response to treatment in these various types is proportionate to the degree of malignancy, the basal-cell variety being the most amenable. Nevertheless, it is generally acknowledged that a more favorable outcome may be anticipated in the squamous-cell type of epithelioma of the ear than of this variety elsewhere in the body. A possible explanation of this fact may be found in a statement of Morrow and Taussig (2) to the effect that squamous-cell epitheliomata of the ear are as a rule less malignant than those occurring in other organs, their growth being slower and the involvement of the lymph glands later.



Figs. 3 and 4. Epithelioma of tragus; same case after radium treatment.

It cannot be too strongly emphasized that no one form of therapy is applicable for all cases of epithelioma of the ear. Numerous considerations must influence the plan of treatment to be adopted, not the least important being the patient's general condition. Among other factors are the following: stage of the process at time of examination; type of previous treatment, if any; location—whether external or internal.

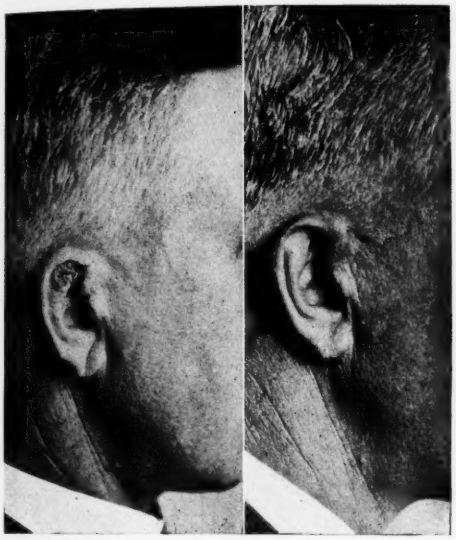


Figs. 5 and 6. Epithelioma of helix; same case after radium treatment.

It is a most regrettable fact that so large a percentage of cases are presented in an advanced stage. This unwarranted neglect often causes complete destruction of the ear, a condition which could have been avoided by early treatment. At present, much hope for the amelioration of this situation may be looked for in the more general education of the public, particularly in the recognition of early signs of the cancerous state.

The number of cases of epithelioma of the ear which previously received some

form of treatment may perhaps be estimated from Dr. Rex Duncan's report (2) of five hundred cases of superficial epithelioma in general, treated with radium. This writer states that a total of 68 per cent of the cases had received previous treatment without obtaining satisfactory results, while in many instances the progress of the disease was accelerated. In his series, 17 per cent had recurred after surgery; 20 per cent had been treated with X-ray, and only 2 per cent with radium, without satisfactory results. Paste had been used unsuccessfully in 9 per cent; actual cautery in 5 per cent; and in the remainder, various caustics and other substances, instead of destroying the deeper cells, had stimulated their growth.



Figs. 7 and 8. Epithelioma of fossa of the helix; same case after radium treatment.

It is often suggested that a great difficulty in treating epithelioma of the ear with radium is to be found in the destruction of cartilage. This feature presents an important consideration, but, by persistent effort, leading to the adoption of proper technic, we have gradually been able to overcome this difficulty. Prompt healing of the lesion, with cosmetic results as favorable as in epitheliomata about the face, is our usual experience.

The writer has, with due appreciation, observed a marked change of attitude on the part of the surgeon, who seems to be coming to a better understanding of the value of radium in these cases. An evidence of this fact may be found in the illustrations which accompany the present article. Two of these cases were referred by surgeons who might have afforded relief to the patient by excising a large portion of the ear, but who chose radium in preference for obvious reasons, including the superior cosmetic results to be obtained.

Fig. 9. The writer's head band applicator.

Among numerous other arguments to be advanced in favor of radium therapy in place of surgery is the fact that radium not alone removes the growth exclusively—due to its selective action for malignant tissue—but it acts as a means of insurance against

recurrence. In addition, it affords no opportunity for the dissemination of malignant cells, as in the case of the surgical process.

In the group of cases in the present series, applications of 50 milligrams of the radium element were made, with one-half millimeter of silver, one millimeter of brass, one millimeter of lead and two millimeters of soft rubber. This was applied for a period of two hours daily, for four consecutive days, the writer's head band applicator being employed to obtain three millimeters of distance, as indicated in Figure 9.

On the whole, radium *per se* seems gradually to have proven its value, and must now be viewed in the light of a new force in the science of therapeutics, possessing a specific action unlike that of any other known agent. Its successful employment, however, as with any other means of therapy, depends upon several factors, not the least essential being the experience and judgment of the radiologist and the proper technical equipment.

As previously suggested, the writer does not claim that radium is a cure-all, nor that it is more efficacious in every case of epithelioma of the ear than are all other forms of treatment; however, given a patient with an average amount of radiosensitiveness, in whom the metastatic state is not too far advanced, there is an immeasurably greater assurance of a favorable outcome as a result of radium therapy than as a result of any other known means at our disposal.

The illustrations which accompany this article show the results and cosmetic effects obtained by following the above technic.

REFERENCES

1. Broders, Albert C.: Surg. Clin. of N. Amer., Oct., 1921, Vol. I, No. 5, p. 1401.
2. Morrow, H., and Taussig, L.: Arch. Derm. and Syph., Jan., 1922, V, 73.
3. Duncan, Rex: Urol. and Cutan. Rev., Jan., 1922, XXVI, 19.

CASE REPORT

SPONTANEOUS PNEUMOTHORAX: REPORT OF A CASE APPARENTLY FOLLOWING WHOOPING-COUGH

By B. A. RHINEHART, M.D, Little Rock, Ark.

The patient is a white female, age 34. Her family history is irrelevant. She gives a history of the usual diseases of childhood, excepting pertussis. She has been married for several years but has not been pregnant. Beginning in January, 1918, she has had an attack of acute respiratory infection each winter, each of which has been diagnosed influenza. No history of pneumonia or of symptoms suggesting tuberculosis was obtainable. In March, 1924, during a local epidemic of whooping-cough, she had a very severe attack of this disease which required hospitalization for a month. During this time she had many severe attacks of coughing, vomiting and choking.

The present symptoms began with the attack of whooping-cough in 1924. Since then there has been a slight dyspnea on exertion, and, during the menstrual periods, a dull aching pain in the lower part of the right side of the thorax. Because of these, the patient was referred to me for examination of the lungs.

A fluoroscopic examination showed the right lung to be partially collapsed, and a small amount of fluid in the right pleural cavity. The upper level of the fluid was an inch below the highest part of the right arch of the diaphragm. The excursions of the arches of the diaphragm were equal. The heart and aorta appeared normal.

Stereoscopic radiograms showed the zone of air around the lung to be one and three-fourths inches wide at the apex, gradually decreasing to a width of three-fourths of an inch at the level of the eighth rib. There were no evidences of adhesions or thickening of any part of the right pleural membrane. The lung was clear of all evidences of tuberculosis or other inflammatory disease. Trunk markings immediately adjacent to the hilus were slightly accentuated,

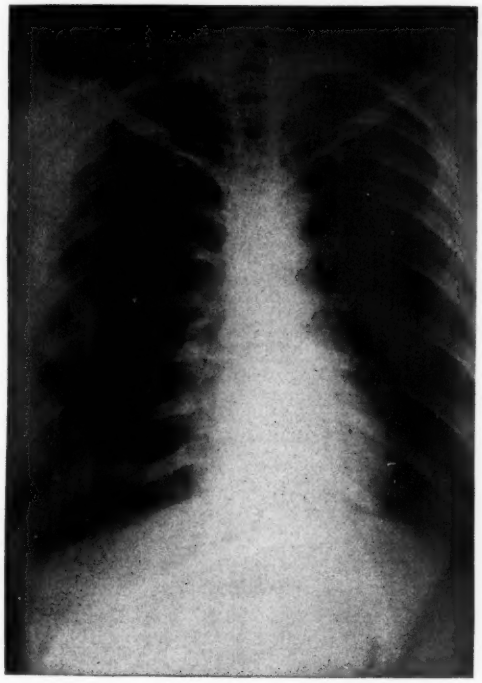


Fig. 1. Radiograph of the chest showing partial collapse of the right lung.

probably due to congestion. Not more than a slight displacement of the heart and other mediastinal contents toward the left was present. The left lung was clear.

Physical examination of the chest gave the usual findings associated with pneumothorax. A few moist râles were heard over the right lung. Because of these râles one physician insisted that the patient had tuberculosis.

In this case I believe that the rupture of the lung was due to the severe strain during

the paroxysms of whooping-cough, and that a pre-existing pleural bleb was the site of the rupture. The formation of the valve of the visceral pleura that opens with coughing and on deep expiration could keep the lung collapsed indefinitely. I think that the patient does not have pulmonary tuberculosis, the râles probably being due to the congestion incident to the collapse of the lung.

Emerson (1) mentions pleurobronchial fistulæ that may, by a valve-like action of the visceral pleura, keep air in the pleural cavity for years. He also says that collapse of the lung from tubercle rupture is usually associated with adhesions that prevent collapse at the apex. I am pleased to note that LeWald (2) emphatically insists that all patients with spontaneous pneumothorax do not have pulmonary tuberculosis.

Soon after our examination this patient went to Colorado, presumably to enter a tuberculosis sanatorium, so that we do not have a subsequent history.

REFERENCES

1. Emerson, C. P.: Non-inflammatory exudates within the pleura. In Tice's "Practice of Medicine," 1925, V, 631-647. W. F. Prior Company, Hagerstown, Md.
2. LeWald, L. T.: Bilateral and unilateral non-tuberculous spontaneous pneumothorax. Arch. Surg., 1926 XII, 440-446.

THE RELATION, RADIOGRAPHICALLY, OF KILOVOLTS PEAK TO TIME OF EXPOSURE

By GLENN W. FILES

OCCASIONALLY a radiogram is made which is lacking in contrast, and it is desired to produce one with greater contrast. Ordinarily the time factor is increased with a corresponding reduction of the K.V.P. factor; the following chart (Fig. 1) has been prepared to assist in determining what change in K. V.P should be made to compensate for a change in time of exposure.

"Radiographic density varies directly as the square of the voltage, all other factors remaining constant."

The above law, and the other three laws regarding density, were based upon the use of plates or films without screens, filters, or Bucky diaphragms, in which instance the above is accurate enough for all practical purposes. At the present time, however, screens, filters, and Bucky diaphragms are in common use, which changes the above law materially from a practical radiographic standpoint.

With screens alone, their speed varies depending upon the energy used; that is, with higher energies, the speed of the screen is increased, and *vice versa*. The cassette usually has 1 mm. of aluminum or its

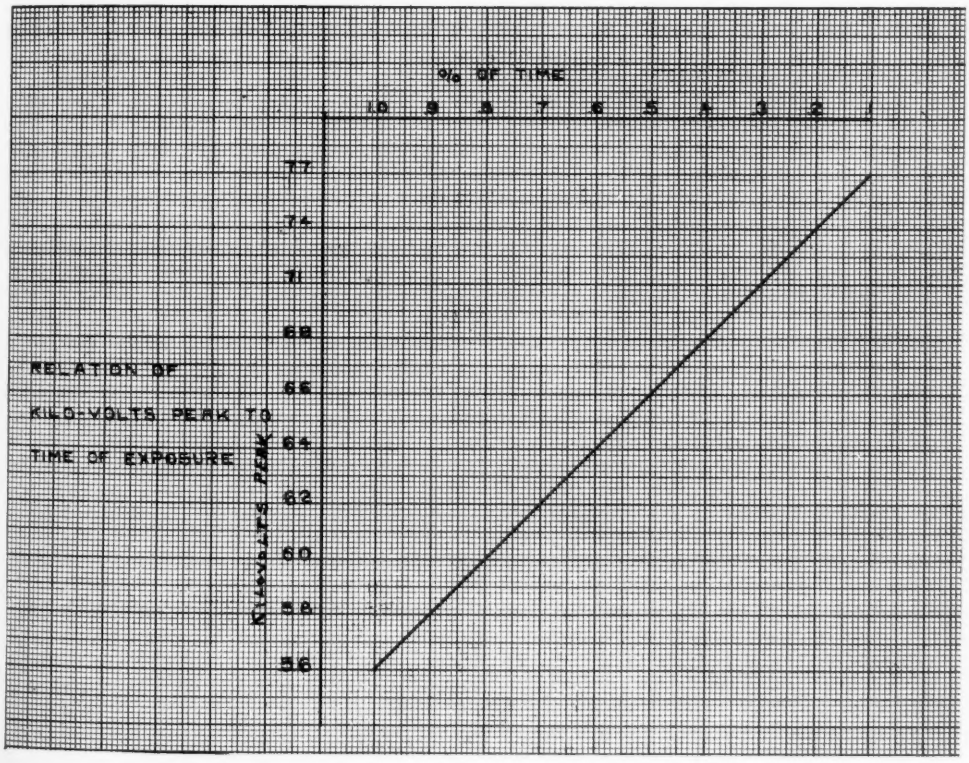


Fig. 1. Not applicable without intensifying screens. Any desired milliamperage or distance may be used.

equivalent on the front. One millimeter of aluminum is commonly used as a filter under the tube. The Bucky diaphragm has a millimeter of aluminum or its equivalent as a top. With the lower voltages, as used in radiography, the screen nearest the tube has some noticeable absorption. So, instead of unfiltered radiation to the film or plate, several filters are used, all of which tend to cause a considerable error in the inverse square law as applied to voltage.

The accompanying chart is based upon practical work and on equipment which has been accurately calibrated with a sphere gap. The kilovolt peak side is relative and should not be taken as the actual K.V.P. necessary to use. The time, it will be noticed, is shown from one-tenth to one unit, which allows for a time change of either one-tenth or ten times a given time.

The use of the chart may be more readily illustrated by actual problems, as follows:

EXAMPLE I

A radiograph using the following technic is being taken: 87 K.V.P., 25 in. dist., 10 ma., 5 seconds.

It is desired to use a longer time of exposure in order that more contrast may be obtained, which necessarily means a decrease in voltage (K.V.P.). The time for this problem is set at 25 seconds.

Five is one-fifth or two-tenths of twenty-five. Upon looking at the chart it is found that the curve crosses the two-tenths line at 74 K.V.P. By subtracting the lowest K.V.P. shown on the chart, that is, 56, from 74 K.V.P., 18 K.V.P. results. The kilovolts peak to use on the 25-second basis, all other factors equal, is 18 K.V.P. lower than on the 5-second basis, or 69 K.V.P.

EXAMPLE II

A radiograph is being made of an extremity using the following settings: 55 K.V.P., 36 in. dist., 10 ma., 5 seconds.

Due to the condition of the patient it is found necessary to use one-half second exposure. One-half is one-tenth of five. The curve crosses the one-tenth line at 77 K.V.P. Again by subtracting 56, or the lowest K.V.P. on the chart, from 77 K.V.P., 21 K.V.P. results. In this case the K.V.P. should be increased 21 K.V.P., or to 76 K.V.P., which would be used on the one-half second basis, all other factors remaining equal.

If a change is desired which either doubles the time or divides the time in half, it will be found that the chart shows 66 K.V.P. at five-tenths or one-half: 66 K.V.P. minus 56 K.V.P. equals 10 K.V.P., which is the proper amount to either decrease or increase the K.V.P for the above increase or decrease in time.

The resulting densities due to changes made according to the chart, are based upon an average diagnostic density. It is naturally very difficult to compare two films for density, if there is a marked difference in contrast between them; that is, a radiograph made using 25 seconds exposure with the correct voltage for this exposure time will show considerably more contrast than a radiograph of the same subject using 5 seconds time with a sufficiently higher voltage to produce a diagnostic density.

EDITORIAL

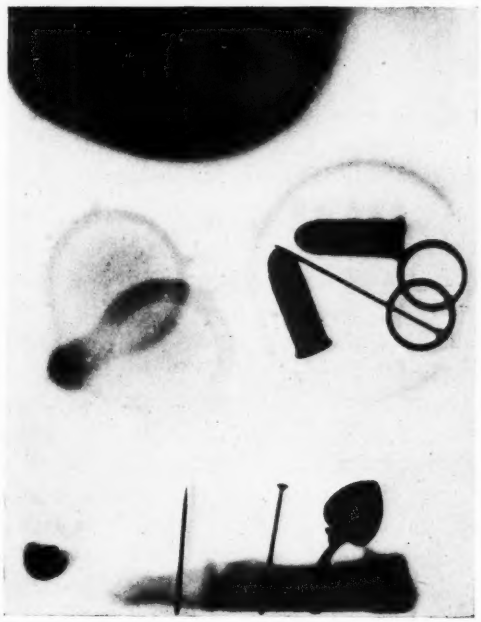
M. J. Hubeny, M.D. . . . . *Editor*
Benjamin H. Orndoff, M.D. } . *Associate Editors*
John D. Camp, M.D. }

Contents of RADIOLOGY copyrighted by the Radiological Society of North America.

SOME SOUTHERN PIONEERS IN X-RAY: AN HISTORICAL NOTE

It is sometimes interesting to engage in reminiscences of the early days of the X-ray. It has interested the writer to recall that during November and December of 1895, the Freshman class at Davidson College, North Carolina, while studying physics under Dr. Henry Louis Smith, now President of Washington and Lee University, was engaged in the study of Crookes' tubes. We Freshmen were mainly interested in the color play rather than the physics of the cathode ray and little did we dream that at the same time Roentgen, as well as many other physicists, were engaged in the study of the same phenomena. It was at just this time that Roentgen made his wonderful discovery of the X-ray.

When we reassembled after the Christmas holidays, Dr. Smith told the classes of the discovery of the penetrating ray. Three enterprising Juniors, being much interested, decided to try it out. Osmond Barringer of Charlotte, North Carolina, Eben Hardie of New Orleans, and Pender Porter, now a physician in Brooklyn, New York, on Sunday night, January 12, 1896, slipped into the laboratory and made the accompanying "picture" on a kodak plate. It required about three hours' exposure. On the plate, as will be recognized, were an egg, a pocket magnifying glass, a finger from a cadaver in the dissecting hall with a bangle ring on it and pierced by pins, a pillbox containing a pin, some cartridges, clips, and calomel tablets. This gave a very good study of densities. For fear of the faculty, these *sub rosa* roentgenologists remained quiet about the experiment for a good while, though many of the students knew about it and saw the plate.



The second "X-ray picture" made in the United States: Davidson College, North Carolina, January 12, 1896.

Unless there were other bold physicists whom we have been unable to locate, this was the second "X-ray picture" made in the United States. The first was made in the North somewhere and we knew of it, though we did not know where it was made until recently. In Pupin's book, "From Immigrant to Inventor," he tells of making a

"picture" in his laboratory in checking the report from Roentgen. This was done January 2, 1896. We have also been interested to learn from this book that he first used the intensifying screens at the suggestion of Edison.

It was only a few weeks later, February 27, 1896, that cuts of other radiograms, made at Davidson College by Dr. Smith, appeared in the *Charlotte Observer* with an article about the wonderful discovery.

Dr. Smith and Davidson College may also claim precedence in the localization of the first foreign body in the trachea—at least we have been unable to find a report in the literature of a body located in the air passages before this date. Codman, in the *Boston Journal of Medicine and Surgery*, July 1, 1896, Vol. CXXXV, page 50, reports locating a jack-stone in the esophagus. In the latter part of December, 1897, Dr. Smith was called to Harrisburg, North Carolina, to see if he could locate a foreign body in a child who was choking. Loading his outfit, consisting of storage batteries, a large induction coil, Crookes' tube and a small hand fluoroscope, in a hack, he drove twenty-five miles through the cold and mud. The child was suspended on a sheet above the tube and an object, which Dr. Smith thought was an open-end thimble, was seen in the midline. A similar thimble was laid beside it and the shadows compared. The child was taken to the hospital in Charlotte and again Dr. Smith was called to take his outfit another twenty miles to show the thimble to the surgeons, Drs. J. R. Irwin and C. A. Misenheimer, who were then able to remove it from the trachea.

The local press wrote much about this and only a few days later Dr. Smith had to journey again to Charlotte to locate a piece of hat pin in a child who had been brought across the State.

These early days are of interest historically, showing how the medical profession soon followed the lead of the anatomist Kölliker in recognizing the value of the X-ray in medicine. It also shows how then, as always, the physicist has been a most important ally to his medical colleague, both as discoverer and developer.

ROBERT H. LAFFERTY, M.D., F.A.C.R.

RUSSELL D. CARMAN: A PERSONAL APPRECIATION

For many years we had corresponded, but it was not till 1921 that I met Carman in a New York hotel. Personalities are often so ill expressed by the written word that it was almost a shock to find the man so different from my mental picture. A man of big physique, with a firm and steady hand shake, a look that quietly and without hurry took good stock of one, and a smile that slowly spread over his kindly face. It was a peculiar smile, almost habitual; one that might easily have been disconcerting had it not been for the personality behind it—an enigmatic smile that always ended in a kindly welcome, a kindly thought and the assurance of good will. We talked far into the night on many subjects, but it was always borne in on one that this man lived, moved and had his being and would spend his every effort in radiology. He was almost afraid of diversions lest they should take him off his trail, for he sought to have his mind running on a single track. Last year, over here, we had been having some music and a walk round among the flowers on a summer evening, and as he left he said, rather pathetically, I thought, "You are lucky to have all these things, but I don't envy them to you —my work is my one hobby." In fact, in spite of his keen enjoyment of everything he seemed to allow himself only one regular diversion, motoring. One day we went together to see some motor races. His childlike enthusiasm and absorbed interest showed that he was perfectly right in limit-

ing his activities to the one aim and object of his life, for he would so easily have gone off at a tangent and become absorbed in whatever he took up.

His powers of organization were well suited to such an institution as the Mayo Clinic, where he had built up a department that was dealing most efficiently with about 60,000 diagnostic cases a year. Everything was reduced, as far as possible, to elemental simplicity, and to see him deal with thirty or forty stomach examinations in an afternoon, palpating each one with routine thoroughness, was to realize the physical and mental stamina of which he was made. And then to go with him at eight o'clock each morning from one operating theatre to another, checking up his cases, was to appreciate something of the thoroughness that has placed the diagnostic work of this clinic on such a high plane.

There are very few men like Carman in this world, and in his untimely death radiology has lost a great personality, one which will leave its impress for many years, and many of us have lost a true friend.

A. E. Barclay, M.D.

COMMUNICATION

In Radiology for June, 1926, page 516, Dr. Jacob Roemer, of Paterson, New Jersey, cites a case which, according to him, shows the effect of small doses of X-rays in causing the resolution of an infiltrative process of the lungs.

He is probably correct in his assumption that the patient was suffering, not from metastasis, but from an inflammatory process. However, in my opinion, the subsequent resolution was due, not to the small dose of X-rays given the second time, but in spite of it. At the second course of X-ray treatment the dose was sufficiently small that it had no particular effect and allowed the inflammatory resolution to take place, whereas, if the dose had been heavier, such inflammation would, in all probability, have been increased.

I feel that this is an example of coincidence and not of any stimulating effect of small doses of X-rays, for which, as we well know, there is very little evidence.

A. U. Desjardins, M.D.

REPLY FROM DR. ROEMER

It is a well known fact that post-operative pneumonia, as well as unresolved pneumonia, responds with splendid results to small X-ray doses in about 80 per cent of the cases. There is ample literature on the subject to support this view. I cannot go here into a lengthy discussion, but will mention below several authorities who have studied the subject with the greatest of care.

It is assumed that in such cases small doses of roentgen ray stimulate antibody formation, and increase the bactericidal power of the blood. It was on this basis that I applied the same treatment to a case of pulmonary infiltration, induced by massive radiation of the chest, and I have every reason to believe that the resolution *ad integrum* was brought about by the treatment. The patient suffered from this condition for about six weeks, and it was getting progressively worse. After the first dose was given there was a decided improvement in the patient's condition, and there was a complete resolution after four fractional doses.

I am confident that this was not a coincidence and that the resolution of the infiltrated lung did not take place in spite of the treatment; rather, it did because of the treatment.

REFERENCES

Stephan, Richard: Ueber die Steigerung der Zelfunktion durch Roentgenenergie. Strahlentherapie, 1920, XI, 517.

JUENGLING, OTTO: Roentgenbestrahlung chirurgischer Krankheiten. Verlag Hirzel, Leipzig, 1924, p. 454.

FRIED, C.: Roentgenbehandlung entzuentlicher Beckenerkrankungen. Strahlentherapie, 1925, XIX, 649.

FRIED, C.: Die Roentgenther. der Postoperativen Pneumonie. Klinische Vochenschr., 1926, Jg 5, No. 1, pp. 15-18.

NEW ENGLAND ROENTGEN RAY SOCIETY

At the last meeting of the above Society, the following officers were elected for the coming year: Dr. P. H. Cook, of Worcester, Mass., *President;* Dr. C. H. Jennings, of Fitchburg, Mass., *Vice-president;* Dr. M. C. Sosman, of the Peter Bent Brigham Hospital, Boston, *Secretary-Treasurer;* Dr. Fred Eveleth, of Concord, New Hampshire, *Member of the Executive Committee.*

COOLIDGE AWARDED MEDAL BY FRANKLIN INSTITUTE

Dr. W. D. Coolidge, Assistant Director of the research laboratory of the General Electric Company and inventor of an X-ray tube which bears his name and which is universally used in hospitals and laboratories, has been awarded the Howard N. Potts Gold Medal for 1926 by the Franklin Institute, of Philadelphia.

The medal, to be formally presented by the Institute on October 20, is "in consideration of the originality and ingenuity shown in the development of a vacuum tube that has simplified and revolutionized the production of X-rays," according to the Institute's citation.

In accepting the medal, Dr. Coolidge will present a paper on his new and powerful cathode ray tube.

THE TWELFTH ANNUAL MEETING OF THE SOCIETY

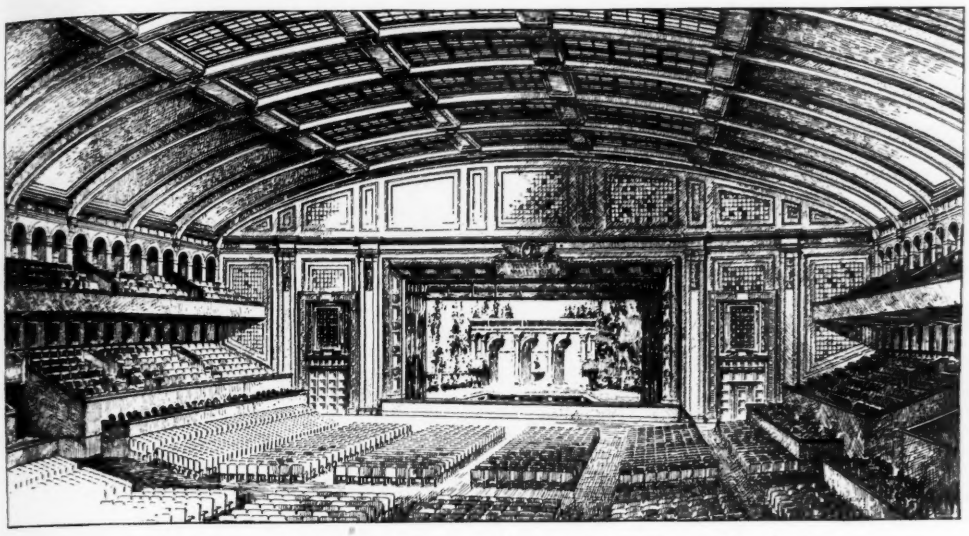
Milwaukee, Nov. 29-Dec. 4, 1926, inclusive.

When the Radiological Society of North America convenes for its Twelfth Annual Meeting this year it will be in a city centrally located for a majority of our members, and with which all will undoubtedly be glad to make or renew acquaintance. Cleveland set a high standard last year in the matters of comfort and entertainment, which the members of the Milwaukee committees promise to equal. Their city has over a half-million citizens, which fact assures visitors high standards of housing and entertainment.

The new Plankinton Hotel has been chosen as headquarters, and there a considerable proportion of the members will doubtless elect to have their rooms. There are, however, other excellent hotels, among which are the following: The Medford Hotel, at Third and Sycamore Streets; the Pfister, at Wisconsin and Jefferson Streets; Hotel Wisconsin, at Third Street near Grand Avenue; Hotel Martin, at Wisconsin and Van Buren Streets; the Astor Hotel, a new apartment hotel in the residence district at Juneau Avenue and Astor Street; the Plaza Hotel, another new apartment hotel, and, like the Astor, on the European plan, located at Martin and Cass Streets, and the Republican House, at Third and Cedar Streets. This last named hotel is one of the well known older houses, which has the reputation of serving excellent food.

The rates at these hotels will be published in a later issue of RADIOLOGY, in ample time for the members who are planning to attend—especially those who expect to bring their wives—to make up their budgets for the trip.

The suggestion has been made that each day adequate time be set aside from the Scientific Sessions to permit the members to visit the Commercial Exhibits, so that no



Interior of the large Auditorium in which the joint meeting will be held, Wednesday, Dec. 1, 1926.

one may feel that he has lost the opportunity to inspect the new apparatus at his leisure. In this way, also, the time of the gentlemen in charge of the exhibits will be conserved.

PRELIMINARY PROGRAM OF THE TWELFTH ANNUAL MEETING

MILWAUKEE, NOV. 29–DEC. 4, 1926

The program of the next Annual Meeting of the Radiological Society of North America is at this date ready for tentative publication only. As much as herewith appears may be considered as fixed, to which additions are still being made. In a later issue of RADIOLOGY the complete program will be announced.

1. ALBERT BACHEM, Ph.D., Chicago, Ill.
   Physiological and Biological Observations of Skin Reactions.
2. E. A. POHLE, M.D., University of Michigan, Ann Arbor, Mich.
   Studies of Capillary Changes as a Result of Roentgen-ray Erythema Occurring in the Human Skin.
3. W. D. COOLIDGE, Ph.D., Schenectady, N. Y.
   Cathode Rays Outside the Generating Tube.
4. A. U. DESJARDINS, Rochester, Minn.
   Analgesic Properties of Roentgen Rays.
5. W. W. BELDEN, M.D., New York City.
   JOHN REMER, M.D., New York City.
   The Diagnosis and Therapy of Intrathoracic Tumors.
6. W. S. LAWRENCE, M.D., Memphis, Tenn.
   The Treatment of Systemic Blastomycosis.

   Executive Session Followed by Counselors' Meeting and Executive Meeting
7. J. T. STEVENS, M.D., Montclair, N. J.
   Treatment of Carcinoma of the

Plankinton Hall, in which the Scientific Sessions of the meeting will be held.

Cervix with Radium, Roentgen Ray and Electrocoagulation.

8. H. H. Bowing, M.D., Rochester, Minn.
   The Treatment of Carcinoma of the Rectum by Irradiation: A Report of a Small Series of Cases.
9. W. T. Bovie, Ph.D., Harvard University, Cambridge, Mass.
   (Title to be announced later.)
10. Maud Slye, University of Chicago, Chicago, Ill.
    Heredity.
11. M. J. Sittenfield, M.D., New York City.
    The Causation of Cancer with Reference to Recent Experimentation.
12. Albert Soiland, M.D., Los Angeles, Calif.
    The Metallic Colloids in the Treatment of Cancer.
13. Hermann Wintz, M.D., Erlangen, Germany.
    The Action of Roentgen Rays on Glands of Internal Secretion.
14. E. A. Pohle, M.D., Ann Arbor, Mich.
    Motion Picture Film of the Human Skin Capillaries.
15. Prof. B. Niekau, from the medical clinic of the University of Tubingen, Germany.
    Human Skin Capillaries and Their Changes during Circulation of the Blood.
16. J. A. E. Eyster, M.D., University of Wisconsin, Madison, Wis.
    Practical Aspects of Radiography of the Heart.
17. Charles E. Ide, M.D., Milwaukee, Wis.
    Correlation of X-ray Films, Clinical Findings and Blood Pressure Readings in a Series of 300 Cases.
18. A. W. Crane, M.D., Kalamazoo, Mich.
    Dilatation of the Thoracic Aorta.
19. B. H. Nichols, M.D., Cleveland, Ohio.
    Some Observations from a Roentgenological Study of the Aorta.
20. W. H. Wallace, M.D., Brooklyn, N. Y.
    Early Infections in the Thorax.
21. H. K. Dunham, M.D., Cincinnati, Ohio.
    The Value of an X-ray Study in the

East Water Street, looking toward the City Hall;
"the Wall Street of Milwaukee"

Care of Cases Suffering from Pulmonary Tuberculosis.

22. U. V. PORTMANN, M.D., Cleveland, Ohio.
Problems in Physiotherapy.

23. H. A. JARRE, M.D., Detroit, Mich.
Lipiodol in Diagnosis and Therapy.

24. ADOLPH HARTUNG, M.D., Chicago, Ill.
The Diagnostic Value of Iodized Oil in Intrathoracic Lesions.

25. STUART PRITCHARD, M.D., Battle Creek, Mich.
BRUCE WHYTE, M.D., Battle Creek, Mich.
J. K. M. GORDON, M.D., Battle Creek, Mich.
The Use of Supra-glottic, Intra-tracheal Injections of Iodized Oil in the Diagnosis of Bronchiectasis. Clinical demonstration.

26. H. P. DOUB, M.D., Detroit, Mich.
Radiation Effects in Nephritis.

Symposium on the Urinary Tract. Chairman: B. H. NICHOLS, M.D., Cleveland, Ohio.

27. W. F. BRAASCH, M.D., Rochester, Minn.
(Title to be announced later.)

28. D. A. EISENDRATH, M.D., Chicago, Ill.
ROBERT ARENS, M.D., Chicago, Ill.
Further Studies of the Normal Renal Pelvis.

29. WALTER M. KEARNS, M.D., Milwaukee, Wis.
Pyelography in Renal Tuberculosis.

30. EDWARD C. KOENIG, M.D., Buffalo, N. Y.
X-ray Assistance in Solving Genito-urinary Problems.

31. VINCENT J. O'CONOR, M.D., Chicago, Ill.
The Value of Ureteropyelography as a Diagnostic Aid.

Executive Session, Election of Officers

32. R. B. BETTMAN, M.D., Chicago, Ill.
ROBERT ARENS, M.D., Chicago, Ill.
Empyema.
33. LE ROY SANTE, M.D., St. Louis, Mo.
Atelectasis, or Massive Collapse of the Lung.
34. F. W. O'BRIEN, M.D., Boston, Mass.
Elevation of the Diaphragm.
35. J. PAUL KEITH, M.D., Louisville, Ky.
D. Y. KEITH, M.D., Louisville, Ky.
J. C. BELL, M.D., Louisville, Ky.
The Significance of Delay of Barium in the Second Portion of the Duodenum.

Symposium on Chronic Stasis in the Upper Intestinal Tract. Chairman: J. F. HERRICK, M.D., Ottumwa, Iowa.

36. W. H. HOLMES, M.D., Chicago, Ill. (Medical)
37. E. A. KELLOGG, M.D., New York, N. Y. (Surgical)
Chronic Duodenal Stasis.
38. J. A. WOLFER, M.D., Chicago, Ill. (Surgical)
39. J. T. CASE, M.D., Battle Creek, Mich. (Radiological)
40. A. C. IVY, M.D., Chicago, Ill. (Pathological)
41. W. C. ALVAREZ, M.D., Rochester, Minn.
Gastric Waves which the Roentgenologist Ordinarily does not See.

Symposium on Colonic Conditions. Chairman: L. J. CARTER, M.D., Manitoba, Canada.

42. L. J. CARTER, M.D., Manitoba, Can.
Colonic Dynamics.
43. J. C. MCMILLAN, M.D., Winnipeg, Can.
Colonic Spasticity.
44. C. M. HENRY, M.D., Regina, Sask., Can.
Colonic Stasis.
45. B. R. MOONEY, M.D., Edmonton, Alberta, Can.
Colonic Ulceration.
46. W. B. MCGUFFIN, M.D., Calgary, Alberta, Can.
Colonic Malignancy.

WISCONSIN DAY PROGRAM

Wednesday, Dec. 1, 8:00 P. M.
Semi-public.

Symposium on Cancer. Chairman: JOSEPH SMITH, M.D., President Wisconsin State Medical Society.

FATHER FOX, President Marquette University. Openings remarks.

47. J. M. MARTIN, M.D., Dallas, Texas.
X-ray Treatment of Skin Malignancies.
48. G. E. PFAHLER, M.D., Philadelphia, Pa.
X-ray and Radium Treatment of Malignancy.
49. W. J. MAYO, M.D., Rochester, Minn.
The Surgical Treatment of Cancer.

Motion Picture

50. J. M. MARTIN, M.D., Dallas, Texas.
The Cancer Problem.
51. IRVING F. STEIN, M.D., Chicago, Ill.
Pneumoperitoneum in Relation to Gynecology.
52. EDWIN C. ERNST, M.D., St. Louis, Mo.
Fluoroscopic Unit.
53. Symposium on Fluoroscopy. Chairman: B. H. ORNDOFF, M.D., Chicago, Ill.

Symposium on the Roentgenological Aspects of the Diagnosis of Diseases of Infants and Children. Chairman: LEON T. LEWALD, M.D., New York City.

54. MAX M. PEET, M.D., Ann Arbor, Mich.
Diagnosis of Cerebellar Lesions.

55. G. J. NOBACK, M.D., New York City.
Further Studies of the Infant Thorax, Thymus and Heart.

56. W. W. WASSON, M.D., Denver, Colo.
The Chest—Diagnosis.

57. E. L. JENKINSON, M.D., Chicago, Ill.
PHILIP LEWIN, M.D., Chicago, Ill.
The Osseous System—Diagnosis.

58. WILLIAM A. EVANS, M.D., Detroit, Mich.
Sinuses and Mastoids—Technic in Roentgen Examination of Children.

59. HENRY G. BUGBEE, M.D., New York, N. Y.
Urinary Tract—Diagnosis.

60. LEON T. LEWALD, M.D., New York, N. Y.
The Digestive Tract.

61. W. B. MULLIN, M.D., Cleveland, Ohio.
An Experimental and Clinical Study Showing the Rôle of the Nasal Accessory Sinuses in the Production of Bronchial Disease.

Symposium on Intra-oral Cancer. Chairman: DOUGLAS QUICK, M.D., New York, N. Y.

62. JAMES EWING, M.D., New York, N. Y. (Pathology)

63. E. STARR JUDD, M.D., Rochester, Minn. (Surgery)

64. CURTIS BURNAM, M.D., Baltimore, Md.
Radium in Intra-oral Cancer.

65. JAMES J. DUFFY, M.D., New York, N. Y.
Treatment of Cervical Nodes in Intra-oral Cancer.

66. CROSBY GREEN, M.D., Boston, Mass.
Electrocoagulation in Intra-oral Cancer.

Symposium on Medical Education with Reference to Roentgenology. Chairman: PRESTON M. HICKEY, M.D., Ann Arbor, Mich.

67. DR. LINDSAY, Ann Arbor, Mich.
The Pre-medical Aspect of the Training of the Roentgenologist.

68. C. R. BARDEEN, M.D., Madison, Wis.
Anatomy and Roentgenology.

69. W. J. MEEK, M.D., Madison, Wis.
The Relation of Physiology to Roentgenology.

70. E. S. BLAINE, M.D., Chicago, Ill.
The Essentials of the Teaching of Roentgenology to Post-graduate Students.

71. PRESTON M. HICKEY, M.D., Ann Arbor, Mich.
The Teaching of Roentgenology to Undergraduates.

Symposium on Intracranial Lesions. Chairman: G. W. GRIER, M.D., Pittsburgh, Pa.

72. L. E. DAVIS, M.D., Chicago, Ill. (Surgical)

73. M. C. SOSMAN, M.D., Boston, Mass. (Radiological)

74. H. L. POLLOCK, M.D., Chicago, Ill. (Neurological)

Symposium on the Nasal Sinuses. Chairman: A. GRANGER, M.D., New Orleans, La.

75. WILLIAM D. SANSUM, M.D., Santa Barbara, Calif.
The Paranasal Sinuses as a Source of Focal Infection.

76. MARION E. BROWN, M.D., New Orleans, La.
Ocular Manifestation of Diseases of the Paranasal Sinuses.

77. H. J. ULLMANN, M.D., Santa Barbara, Calif.
Roentgen Diagnosis of Nasal Sinus Disease.

78. J. R. HUME, M.D., New Orleans, La.
Diagnosis and Treatment of Nasal Sinus Disease.

79. A. W. PROETZ, M.D., St. Louis, Mo.
EDWIN C. ERNST, M.D., St. Louis, Mo.
Displacement Method of Sinus Diagnosis with Iodized Oils.

ANNUAL BANQUET

80. T. O. MENEES, M.D., Grand Rapids, Mich.
Oral Cholecystography.

81. B. R. KIRKLIN, M.D., Rochester, Minn.
Newer Developments in Cholecystography.

82. SHERWOOD MOORE, M.D., St. Louis, Mo.
Cholecystography.

83. CHARLES G. SUTHERLAND, M.B. (Tor.), Rochester, Minn.
Duodenal Ulcer: Comparison of the Roentgenologic and Histologic Findings.

84. S. C. BARROW, M.D., Shreveport, La.
Roentgen Analysis of Bone Lesions.

85. E. L. JENKINSON, M.D., Chicago, Ill.
(Title to be announced.)

86. HENRY W. MEYERDING, M.D., Rochester, Minn.
Discussion of Radiological Findings, Age, Sex, Incidence, Treatment and Possibility of Recurrence in a Review of a Group of Several Hundred Cases of Exostoses.

87. MAX KAHN, M.D., Baltimore, Md.
L. C. COHN, M.D., Baltimore, Md.
Diagnosis and Treatment of Bone Lesions of the Hand and Foot, with Special Reference to Bone Tumors.

88. WILLIAM C. MACCARTY, M.D., Rochester, Minn.
Pathology of Bone Lesions.

89. M. A. BERNSTEIN, M.D., Chicago, Ill.
Unusual Bone Lesions and Their Diagnosis (Cases of Epiphyseolysis).

90. LYELL C. KINNEY, M.D., San Diego, Calif.
A. E. ELLIOTT, M.D., San Diego, Calif.
Explosive Fractures of the Head of the Humerus.

91. STANLEY J. SEEGER, M.D., Milwaukee, Wis.
Pancreatic Lithiasis.

92. J. A. EVANS, M.D., La Crosse, Wis.
Carcinoma of the Splenic Flexure.

93. H. P. MILLS, M.D., Phoenix, Ariz.
W. W. WATKINS, M.D., Phoenix, Ariz.
Localization of Foreign Bodies in the Eye.

94. R. G. ALLISON, M.D., Minneapolis, Minn.
Recognition of Non-opaque Foreign Bodies in the Air Passages.

95. CHARLES F. BOWEN, M.D., Columbus, Ohio.
Diagnosis and Removal of Foreign Bodies in the Bronchus and Esophagus.

96. L. G. COLE, M.D., New York, N. Y.
Roentgenological Technic.

97. I. SETH HIRSCH, M.D., New York, N. Y.
Roentgenological Conditions in Russia.

98. T. B. YOUNG, M.D., Scottsbluff, Neb.
A. L. COOPER, M.D., Scottsbluff, Neb.
A Study in Paleopathology.

99. ISAAC GERBER, M.D., Providence, R. I.
Further Observation on the X-ray Treatment of Bronchial Asthma and Allied Conditions.

Symposium on Public Health. Chairman: M. J. HUBENY, M.D., Chicago, Ill.

100. HERMAN N. BUNDESEN, M.D., Health Commissioner of Chicago.
The Rôle of the X-ray in Public Health.

101. WESTON A. PRICE, M.D., Cleveland, Ohio.
Dental Infections: Their Dangers and Prevention.

SMOKER

102. EDWARD H. SKINNER, M.D., Kansas City, Mo.
Chronologic Changes of the Human Vertebral Column: Their X-ray Analysis.

103. JOHN D. CAMP, M.D., Boston, Mass.
Radiation Therapy of Intracranial Lesions.

104. JOHN D. MACRAE, M.D., Asheville, N. C.
Therapy.

105. H. J. ULLMANN, M.D., Santa Barbara, Calif.
The Use of Colloidal Lead in Cancer after the Method of Blair Bell: Preliminary Report.

106. ROBERT S. LANDAUER, Ph.D., Physical Laboratory of Standard X-ray Company, Chicago, Ill.
Research Work.

107. MONTROSE T. BURROWS, M.D., St. Louis, Mo.
LOUIS H. JORSTAD, M.D., St. Louis, Mo.
EDWIN C. ERNST, M.D., St. Louis, Mo.
Vitamins in Carcinoma and the Effects of X-ray Radiation.

108. OTTO GLASSER, Ph.D., New York, N. Y.
Further Studies on the Influence of the Radiation Quality on the Measured Intensity of the Erythema Dose.

109. I. S. TROSTLER, M.D., Chicago, Ill.
Malpractice and Insurance Problems.

110. FRANK BISSELL, M.D., Minneapolis, Minn.
Rationale of Gall-bladder Diagnosis.

BOOK REVIEWS

RÖNTGENDIAGNOSTIK INNERER KRANKHEITEN. By DR. FRITZ MUNK. Leipzig, Georg Thieme, 1926.

This is a third edition of a small manual on roentgen diagnosis of internal disease that has proved to be very popular in Germany. As its subtitle indicates, it is a manual for physicians and students and not primarily for specialists. The substance of this text book has for many years been the basis for the instruction in roentgenology at the University of Berlin. Although the entire work covers only about three hundred pages, it furnishes a very complete outline of every branch of internal medical diagnosis. The chief point of view is to give the physicians or students an idea of the various fields in which roentgen diagnosis has proved to be of value. In this edition this general point of view has not prevented the author from giving a very excellent abstract, that will be found of interest even to the advanced specialist. The relation of X-ray diagnosis to the pathology of cardiac disease and to lung disease has been particularly well worked out. In abdominal diagnosis, all the newer refinements have been included, even the recent methods of cholecystography, and are accompanied by excellent radiographs. In the chapter on joint diseases the author describes his own classification, based entirely upon X-ray appearances. This he has found for many years to be a very useful clinical classification.

The character of the illustrations is particularly noteworthy. There are over three hundred plates in this small work and practically all of them are reproductions from original films. The technical character of the reproductions has been particularly satisfactory, so that the details described in the text are all clearly visible in the plates. Al-

together, this work makes a very excellent general introduction to the field of internal roentgen diagnosis, and represents a type of work which we ought to have popularized in this country in English.

ISAAC GERBER, M.D.

INTERNATIONAL CLINICS

Vol. I, Thirty-sixth Series, 1926

This volume is richly illustrated, as is customary with this publication, well written, and contains contributions so widely diversified that any physician, no matter what his specialty, can find something both interesting and instructive.

H. B. Cushing reviews the sequelæ of diphtheria and brings out the importance of early treatment with adequate dosage of antitoxin by the intravenous method.

Edward C. Reifenstein, on cardiac arhythmias, concludes that one must be familiar with the mechanism of the impulse formation and transmission, that many irregularities may be clinically recognized.

G. Paul Laroque, on "The Treatment of Appendicitis," emphasizes many important points.

L. M. Jourda, in "Blood Dilution in the Pathology and Treatment of Attacks of Gout," points out the relation of the blood dilution measured by viscosity or any other means, to the abnormal constituents in the blood, thus determining the course of treatment necessary.

Professor E. Kraepelin surveys the recent development of psychiatrical research.

F. Plaut has an article on "The Treatment of Metasyphilitic Disorders of the Nervous System with Infectious Diseases, in Particular with Relapsing Fever."

Astley P. C. Ashhurst beautifully illustrates and describes the normal motion of the large joints of the body.

In the section on electrotherapeutics and physiotherapy, F. DeKraft gives a very concise and instructive review of the clinical action of diathermy. W. B. Snow points out the use of and benefits derived from physiotherapy in the treatment of local infections. Joseph Muir, on "Radiotherapy of the Blood and Lymph-tissues," and C. Jeff Miller, on "Contra-indications to the Use of Radium in Gynecology," give advice of the best in the use of this form of therapy.

F. Parkes Weber cites twenty cases of paraplegia in Hodgkin's disease.

Norman B. Gwyn gives a well illustrated and complete treatise upon "Massive Collapse of the Lungs."

The title, "The Life History of a Case of Nephrosis," by Edward H. Mason, accurately describes this article.

In surgery, what could be more interesting than "A Day in Charles H. Mayo's Clinic," by William A. Hendricks?

Edmund Horgan gives concise and exact information on the diagnosis and treatment of acute, superficial, circumscribed abscesses.

"The Surgical Treatment of Gastric and Duodenal Ulcers," by Charles F. Nassau, describes a new method of gastro-enterostomy.

Walter M. Brickner and Henry Milch, under the title "Surgical Clinics from the Broad Street Hospital, New York," cite cases of pathological fractures and traumatic lesions of the abdomen and knee joint.

The last seventy-five pages of the volume are taken up by "Progress of Medicine for 1925," containing reviews of articles by the foremost writers, and cover all that the title suggests. This volume is not an encyclopedia, but every physician can well afford the time it takes to read each paragraph.

B. C. CUSHWAY, M.D.

ABSTRACTS OF CURRENT LITERATURE

INDEX TO ABSTRACTS IN THIS ISSUE

BELFIELD, W. T., and ROLNICK, H. C. Roentgenotherapy and Therapy with Iodized Oils. 275, 276

BRAMESFELD, H. Light Therapy in Gynecology.. 272

BREITLANDER, K., and JANSSEN, K. Comparative Measurements of Roentgen Rays with the Iontoquantimeter (Wintz) and Ionimeter (Martius); a Contribution to the Standard Dosimetry in Roentgen Units..... 274

BRUGMANN, W. Lymphogranulomatose and Roentgen-ray Treatment..... 275

BRUMMER, K. The Electrical Charge of Erythrocytes as the Principal Factor of the Sedimentation Velocity..... 275

BUCKSTEIN, JACOB. Deformity of the Air Bubble of the Stomach in Carcinoma..... 276

BURGHEIM, F. (*with* LEVY-DORN, M.)..... 271, 272

COLE, WARREN H. (*with* GRAHAM, EVARTS A., COPHER, GLOVER H., and MOORE, SHERWOOD) 277

COPHER, GLOVER H. (*with* GRAHAM, EVARTS A., COLE, WARREN H., and MOORE, SHERWOOD). 277

DEMEL, R. Animal Experiments with Roentgen Rays Administered to the Brain..... 276

DONNELLY, WILLIAM H., and REISMAN, HENRY A. The Diagnosis of Incipient Tuberculosis in Children. 277, 278

FISHBERG, MAURICE. Diagnosis of Pulmonary Neoplasm. 269, 270

GAERTNER, O. Measurements of X-ray Intensity with the Ionization Method..... 270, 271

GAERTNER, O. The Significance of Soft Roentgen Rays for Experiments with Bacteria.... 275

GRAHAM, EVARTS A., COLE, WARREN H., COPHER, GLOVER H., and MOORE, SHERWOOD. Cholecystography: The Use of Phenoltetraiodophthalein 277

GRAHAM, R. S. (*with* McCOY, C. C.)..... 272

HAXTHAUSEN, H. Finsen Therapy of Lupus Vulgaris with Intensified Light and the Use of a Special Glass Filter to Absorb the Radiant Heat Rays..... 276

HILSNITZ, O. Early Histological Changes in Roentgen-rayed Skin..... 273

HORNICKE, C. B. To What is the Light Protection of Tannin Due?..... 276

IGLAUER, SAMUEL. Use of Injected Iodized Oil in Roentgen-ray Diagnosis..... 273

JANSSEN, K. (*with* BREITLANDER, K.)..... 274

KROPATSCH, A. (*with* LINSER, K.)..... 271

LAPATSANIS, P. Contribution to the Systemic Effect of Roentgen Rays on the Human Organism 272

LEVY-DORN, M., and BURGHEIM, F. Effect of Roentgen Radiation on Cholesterin Content of the Blood in Health and Disease..... 271, 272

LINSER, K., and KROPATSCH, A. Sensitization and Desensitization of the Skin to Ultraviolet Light..... 271

McCOY, C. C., and GRAHAM, R. S. Experience with Cholecystography in Cases Coming to Operation. 272

MENEES, THOMAS O. Intragastric Radium Treatment of Carcinoma of the Stomach.... 274

MERTZ, A. Ferment Increase in the Serum after Light and Roentgen Therapy an Index of Cell Destruction..... 272, 273

MOORE, SHERWOOD (*with* GRAHAM, EVARTS A., COLE, WARREN H., and COPHER, GLOVER H.) 277

MORRISSEY, EDMUND J. (*with* WOLFSOHN, JULIAN M.) 275

OBER, FRANK R. Diagnosis in Orthopedic Surgery 271

PORDES, F. Vital Indication for Roentgen Therapy in Cases of Perimandibular Phlegmon 272

REISMAN, HENRY A. (*with* DONNELLY, WILLIAM H.)..... 277, 278

ROLNICK, H. C. (*with* BELFIELD, W. T.)..... 275, 276

RUMP, W. (*with* WINTZ, H.)..... 273, 274

RUMP, W. (*with* WINTZ, H.)..... 277

SCHNEIDER, G. H. Investigations of Biologically Equal Radium and Roentgen-ray Doses..... 276

SCHNEIDER, G. H. Regarding Some Undesirable Effects in Roentgen-ray Treatment of Benign Genital Diseases..... 277

SLOAN, EDWIN P. Duodenal Ulcer from Partial Obstruction at the Duodenojejunal Junction. 278

SUSANI, O. Extraction of Needles and Fish Hooks. 278

WINTZ, H., and RUMP, W. Biological Effect of Roentgen Rays of Various Qualities..... 273, 274

WINTZ, H., and RUMP, W. The Roentgen Photometer. 277

WOLFSOHN, JULIAN M., and MORRISSEY, EDMUND J. Tumors of the Cauda Equina..... 275

WYNEN, W. Hyperemia as Sensitizer for X-rays in Therapy..... 277

XARPELL, C. The Use of Paraffin as Scattering Material in Roentgen Deep Therapy..... 273

Cancer of the lung.—There has been an apparent increase in cancer of the lung in recent years. Pathologists have noted the increase, which is probably an actual one.

The present article is based on 60 cases of lung malignancy. The diagnosis was made during life in the majority of cases. The average age of patients was 55 years. Thirty-six of the 60 were autopsied; 35 showed carcinoma; only one showed spindle-cell sarcoma.

The macroscopic picture of the carcinomatous lung is exceedingly varied, owing not only to the variety of forms in which the tumor itself may grow, but, even more, to secondary nutritive and circulatory disturbances in the tumor tissue and the mechanical

consequences of compression by the growing tumor; to these may be added changes due to infection of the growth with any of the pyogenic micro-organisms, which is not infrequent.

As regards their macroscopic appearance, Fishberg divides his cases into four groups, as follows:

"1. The most common picture is that of an irregularly delimited yellowish or grayish mass in the vicinity of the hilum, infiltrating the parenchyma more peripherally, usually of the hilum of the upper lobe. On section of the tumor, one can often discover the still patent lumen of the bronchus from which the tumor took its origin.

"2. Another, not so common, finding is that of a coarsely nodular mass embedded in the parenchyma of any part of the lung, with much better defined outlines than the tumors of the first-mentioned group.

"3. A further rare form is a diffuse carcinomatous infiltration of one or more lobes, whose appearance presents great similarity to that of an extensive caseous pneumonia.

"4. Three of our cases were the much disputed 'endothelioma of the pleura,' the lung being covered by a thick nodular sheet. The so-called primary miliary carcinosis, though it undoubtedly occurs, was not observed in our series, but we have seen it many times in cases of secondary cancer of the lung. Closely neighboring on the primary growth are often seen metastases to the pulmonary parenchyma. Extensions from the primary growth along the peribronchial and, not so commonly, the perivascular lymphatics may form a prominent feature. In some cases the eye is first struck, when the breast plate is removed, by peculiar patterns outlined on the pleural surface through the permeation of the subpleural lymphatics by carcinoma cells, known as lymphangitis carcinomatosa."

He continues: "Secondary changes in the tumor itself and reactive phenomena on the part of the adjacent lung tissue form an integral part of the picture. The tumor may proliferate so rapidly as to outgrow its blood supply with consequent necrosis of the central portions. The necrotic tissue may be evacuated through the bronchus with resulting cavity formation. Very much as in tuberculosis, these cavities may become secondarily infected and at necropsy are often found full of pus and lined with a pyogenic membrane. Aneurysmal dilatations of vessels may be found projecting into the cavity. There may be many discrete cavities, or one large one."

Twenty of the thirty-six tumors were of columnar type cells—tending to adenocarcinomatous type; twelve were of squamous cells; three belonged to the type of endothelioma of pleura.

In nearly all of the primary carcinomas of the lung other organs were involved; there seemed to be no definite predilection for any one organ. It is often difficult and at times impossible to decide whether the tumor in the lung is a primary or secondary growth.

The onset is insidious in nearly all cases; cough, dyspnea, pain in the chest or hemoptysis were in a few instances the symptoms of onset. In over 90 per cent of instances, cough was the first symptom. The sputum was at first scant—later becoming abundant. It was often blood-streaked and at times carcinoma cells could be found in it; dyspnea, stridor and cyanosis were early developments. In a few cases the disease was afebrile throughout—in some the temperature was as high as 104 degrees. Emaciation was not an early symptom. Pain in the chest is one of the cardinal points in primary carcinoma of the lung.

In the author's experience physical exploration of the chest is more likely to indicate the location of the growth at an early stage than the roentgen rays. Roentgenography is, of course, of decisive diagnostic import in many cases.

L. R. SANTE, M.D.

Diagnosis of Pulmonary Neoplasm. Maurice Fishberg. Archiv. Int. Med., June 15, 1926, p. 745.

Ionization measurements of roentgen rays.—The possible errors of the ionization method of measuring the roentgen-ray intensity have been investigated experimentally in

detail by the author; as it is not possible to do full justice to this important work in a brief abstract, a study of the original is recommended.

The results are principally that the ionization method, carefully carried out, will give reproducible results. The "ionization," *i.e.*, the ionization current in 1 c.c. irradiated air under normal conditions, may be chosen as the reproducible unit. If the kinetic energy of the primary electrons is entirely used for ionization and no primary electrons are emitted by the interior of the ionization chamber except by the primarily irradiated air volume, the allowed error in defining $\frac{I}{V}$ experimentally, can be reduced to 2 per cent. The average length of the path of the electrons excited in air by roentgen rays is much smaller than one might expect according to Einstein's equation, if photoelectrons only would be formed. Therefore, it is not necessary to use chambers of one meter diameter to prevent absorption of the primary electrons in the chamber wall; for 0.09 A, a diameter of 25 cm. will suffice.

E. A. POHLE, M.D.

Measurements of X-ray Intensity with the Ionization Method. O. Gaertner. Strahlentherapie, 1926, XXII, 379.

Roentgen-ray findings in orthopedic cases.—The author, in the Chairman's address before the Section on Orthopedic Surgery, stresses his opinion that most failures in orthopedic diagnosis are due to lack of proper training, incomplete examination of the patient, and too great dependence on the roentgen-ray findings.

He compares the roentgen ray, as a diagnostic instrument, to the clinical thermometer, and indicates that, in his opinion, both are capable of giving valuable findings, but neither is to be depended upon for the making of a complete diagnosis.

He makes no mention of the importance of expert interpretation of roentgen-ray findings, states that widely different conditions can give similar roentgen-ray appearances, and, of course, does not stress the fact that very many errors in orthopedic roentgen-ray interpretations are due to the fact that orthopedists, themselves, inadequately trained in X-ray interpretation, attempt to function as their own roentgenologists.

CHARLES D. ENFIELD, M.D.

Diagnosis in Orthopedic Surgery. Frank R. Ober. Jour. Am. Med. Assn., June 12, 1926, p. 1813.

Sensitization to ultra-violet rays.—It is generally accepted that pigmented skin offers a protection to further exposure to ultra-violet rays. Recent observations seem to make this assumption questionable. There are cases of unpigmented patients who show the same tolerance for ultra-violet light as those who have been treated previously with this radiation, and, on the other hand, colored patients responded to ultra-violet rays with a more severe erythema than white persons. A study of this discrepancy revealed that previous exposure to ultra-violet rays may cause sensitization or desensitization. Very interesting is the existence of a desensitized border zone of untreated skin around the previously treated area. This zone may show less reaction; a second treatment of the field will cause a more severe erythema than the first exposure. Experiments with extracts of treated skin injected into non-exposed persons did not lead to positive results. The behavior of treated and untreated skin grafts transplanted on treated and untreated areas also demonstrated the change in the cell reaction to light caused by previous exposure. A further study of the pigment metabolism under light influence is desirable.

E. A. POHLE, M.D.

Sensitization and Desensitization of the Skin to Ultra-violet Light. K. Linser and A. Kropatsch. Strahlentherapie, 1926, XXII, 514.

Cholesterin in the blood of irradiated patients. — The cholesterin content of the serum before and after roentgen therapy of patients has been studied; some report a decrease, others an increase, working with animal and human blood *in vitro*. A series of animal and clinical investigations were carried out by the authors to find an explanation for this discrepancy. They found that for animal

experiments, large enough warm blooded omnivora have to be chosen; as, for instance, dogs. Three hours after the treatment a definite decrease of the cholesterin was observed. It returned to normal in several weeks' time. Decrease in cholesterin seems to be accompanied by roentgen sickness. In patients suffering from malignant tumors, the cholesterin is increased after irradiation. These cases usually have less cholesterin than normal before treatment. It is possible to use this observation for differential diagnosis. Cancer cases had less cholesterin in 1 c.c. of blood than in 1 c.c. of serum; the reverse ratio is true in other diseases.

E. A. POHLE, M.D.

Effect of Roentgen Radiation on Cholesterin Content of the Blood in Health and Disease. M. Levy-Dorn and F. Burgheim. Strahlentherapie, 1926, XXII, 538.

Vital indication for X-ray therapy.—A wisdom tooth when breaking through the mucous membrane can cause an inflammation which may lead to the dangerous perimandibular phlegmon. The same result may follow the extraction of such a tooth atypically located in the mandible. The author has seen very good results in 237 cases from X-ray treatment of this condition, with 15 to 20 per cent S.U.D. through 5 mm. Al.

E. A. POHLE, M.D.

Vital Indication for Roentgen Therapy in Cases of Perimandibular Phlegmon. F. Pordes. Strahlentherapie, 1926, XXII, 550.

Systemic effect of roentgen rays.—In gynecological cases, the blood sugar, the coagulability, the sedimentation velocity, the blood picture and the hydrogen ion concentration in the urine of the patient, were studied before and after roentgen irradiation. The principal result was that the changes observed varied greatly with the individual and did not show any relation to disease or dose. It is emphasized that this fact again proves the necessity of the individually adapted radiation treatment, and speaks against the use of a standard procedure.

E. A. POHLE, M.D.

Contribution to the Systemic Effect of Roentgen Rays on the Human Organism. P. Lapatsanis. Strahlentherapie, 1926, XXII, 484.

Light therapy in gynecology.—The clinical experience with a non-burning carbon arc lamp (ultra-sun) in treating 150 cases of leucorrhea, diseases of the adnexa, parametritis, hypoplasia of the uterus, and disturbances of menstruation, is set forth in this paper. The author recommends the use of this lamp because the mucous membrane can be treated without irritation and the light may be directed to the lesion by means of special applicators.

E. A. POHLE, M.D.

Light Therapy in Gynecology. H. Bramesfeld. Strahlentherapie, 1926, XXII, 352.

Studies of intravenous and oral methods.—The authors report in detail twenty-six cases, studied mostly by the intravenous method, that afterward came to operation. They report findings in one of three ways: first, normal biliary tract; second, pathological biliary tract; third, cholelithiasis.

Tabulated on the basis of these reports, they have achieved a diagnostic accuracy of 96 per cent in their own cases, injected intravenously.

They also tabulate 212 cases of intravenous administration, from the literature, showing 91 per cent of operative confirmations. They report that the literature shows an average of 80 per cent operative confirmation in cases examined by the oral method.

CHARLES D. ENFIELD, M.D.

Experience with Cholecystography in Cases Coming to Operation. C. C. McCoy and R. S. Graham, Jour. Am. Med. Assn., June 19, 1926, p. 1899.

Ferment increase after light and roentgen therapy.—In cases of injuries caused by light rays, a ferment peptidase appears in the serum; the amount of this ferment seems to

be dependent upon the amount of tissue destruction. Human beings show peptidase in serum and urine to a certain, for the individual, almost constant extent. The author studied, therefore, its quantitative change in patients after tungsten arc lamp, mercury vapor lamp, sunlight, and roentgen exposure. It appears that after all these applications—except that of the tungsten lamp—the peptidase content in serum and urine is definitely increased; the highest readings were obtained after roentgen irradiation. The systemic effects observed after radiation therapy are discussed; it is possible that the debris of cells causes a protoplasm activation in the sense of an unspecific protein given parenteral.

E. A. POHLE, M.D.

Ferment Increase in the Serum after Light and Roentgen Therapy an Index of Cell Destruction. A. Mertz. Strahlentherapie, 1926, XXII, 301.

Paraffin as secondary radiator in deep therapy.—The author describes the roentgen deep therapy technic followed in the Radiological Institute in Barcelona. The dose is carefully measured, using an iontoquantimeter (Wintz), an ionimeter (Solomon), an electroscope (Dessauer), a spectograph (Seemann), and a Furstenau intensimeter; arrangement and number of fields of entry are outlined for each individual case to get a definite idea of the total X-ray energy administered to the diseased part of the body.

The uneven and asymmetrical surface of the body is transformed into a more geometrical form (cube) by means of paraffin which serves as moulding material. The theoretical foundations of this method are demonstrated and fully explained in the case of carcinoma of the breast, superficial tumors, sarcoma of the extremities, and tubercular joints. The principle is the homogeneous distribution of the X-ray energy throughout the diseased zone with the minimum dose required.

E. A. POHLE, M.D.

The Use of Paraffin as Scattering Material in Roentgen Deep Therapy. C. Xarpell. Strahlentherapie, 1926, XXII, 237.

Iodized oil.—The author gives a brief history of the development of iodized oil in chest diagnosis, describing the various methods of introducing the different preparations, and culminating in a description of an intubation method, devised by himself, for which he claims the following advantages: (*a*) simplicity; (*b*) universal applicability; (*c*) small need for co-operation from the patient, and (*d*) unlikelihood of the oil being coughed up.

Some cases are cited, including two cases of tuberculosis that showed bacilli in the sputum after injection, although they had not previously been present. One film is reproduced, showing a filled tuberculous cavity.

In a few cases dyspnea occurred shortly after injection. Usually there was a febrile reaction, sometimes lasting several days. Traces of the oil could frequently be demonstrated in the lung several weeks after injection. The oil should not be injected in febrile or cachectic patients or in those with decompensated heart lesions. The diagnostic scope of the method is defined in accordance with the author's ideas.

CHARLES D. ENFIELD, M.D.

Use of Injected Iodized Oil in Roentgen-ray Diagnosis. Samuel Iglauer. Jour. Am. Med. Assn., June 19, 1926, p. 1879.

Early histological skin changes after X-ray exposure.—Bierich has reported that the elastic fibers in the skin of mice are increased after a short roentgen exposure. His experiments were repeated by the author, who used white mice and irradiated an area on the back 3×1 cm. in size. Immediately after the exposure, and also twenty-five hours later, excisions were made and the skin pieces fixed and stained. A careful comparison with the normal skin did not reveal an increase of the elastic fiber element.

E. A. POHLE, M.D.

Early Histological Changes in Roentgen-rayed Skin. O. Hilsnitz. Strahlentherapie, 1926, XXII, 525.

The biological effect of roentgen rays of various wave lengths.—The results of meas-

urements with the electroscope, iontoquantimeter, Siemens dosimeter, and roentgen photometer (Wintz-Rump) are compared with the biological erythema dose. It appears that long wave lengths of roentgen rays are biologically more effective than shorter wave lengths, if the dose is based on an ionization instrument. All dosimeters have a maximum sensitivity to a certain wave length; they record, therefore, different scattering intensities. A curve is given to allow corrections for fields of various sizes, based on a standard field of entry of 6×8 cm. The scattered radiation in air amounts to aproximately 0.5 per cent of the primary intensity.

E. A. POHLE, M.D.

Biological Effect of Roentgen Rays of Various Qualities. H. Wintz and W. Rump. Strahlentherapie, 1926, XXII, 451.

Intragastric application of radium.—The author reports a modification of his previously reported technic for the intragastric application of radium. The apparatus, as now described, consists of a stomach tube, with a rubber balloon cemented to the gastric end. Wire runs the full length of the tube, ending, on the gastric end, with a spiral spring, to which is attached the radium container, both, of course, being inside the balloon. The other, or upper, end of the wire is attached to the piston of a syringe, over the hub of which the end of the stomach tube is slipped. Two or three inches below the syringe, a "T" piece is inserted into the tube, to which is attached the bulb of a blood pressure instrument.

In use, the patient swallows the balloon containing the radium applicator, and the attached tube. The balloon is then inflated under fluoroscopic guidance, the air in the balloon serving to outline the gastric filling defect, and the radium applicator is moved into position by manipulation through the piston of the syringe. Posture and gravity are made use of in placing the radium.

The author uses 50 mgs. of radium, screened with 0.5 mm. of silver, and makes applications varying from one to three hours in length.

He reports very remarkably good palliation in some cases, and shows tracings of films, in which massive filling defects have been made to disappear following treatment. He states that there is little danger in the method, as prolonged radiation of normal stomach wall is avoided.

CHARLES D. ENFIELD, M.D.

Intragastric Radium Treatment of Carcinoma of the Stomach. Thomas O. Menees. Jour. Am. Med. Assn., June 19, 1926, p. 1904.

Measurement of roentgen rays in R-units.—Two measuring instruments, the iontoquantimeter (Wintz), and the ionimeter (Martius), were compared on the basis of the depth dose. The iontoquantimeter showed a relatively higher value than the other instrument. This discrepancy is explained by the different volume of the chambers used, the different position of these chambers in relation to the surface of the phantom, and their different wall materials. When checking the biological dose (S.U.D.) used on two deep therapy machines with the ionimeter which had been standardized before in roentgen units, the authors noted that their average dose (chamber in air) was 500 *R;* the scattered radiation amounted in the maximum to only 41 per cent (192 K.V., 4 ma., 1.0 Zn. plus 1.0 Al., 50 cm. F.S.D. 15×20 cm. field). The findings differed somewhat from those of other investigators who gave 600 *R* as the average erythema dose, measured with a chamber in air, and 80 to 100 per cent scattered intensity in addition if the chamber is placed on the phantom. The control of the primary potential and the potential on the tube terminals demonstrated that it is not possible to balance line fluctuations by keeping the reading of the kilovoltmeter on the switchboard constant.

E. A. POHLE, M.D.

Comparative Measurements of Roentgen Rays with the Iontoquantimeter (Wintz) and the Ionimeter (Martius); a Contribution to the Standard Dosimetry in Roentgen Units. K. Breitlander and K. Janssen. Strahlentherapie, 1926, XXII, 263.

Electric charge of erythrocytes and sedimentation velocity.—Human blood in sodium citrate solution, defibrinated blood, and washed blood corpuscles in sodium chloride solution, were exposed to roentgen rays in order to study the mechanism of the sedimentation. It appears from these experiments that roentgen rays discharge the erythrocytes and the result is an increased sedimentation velocity. Mechanical factors are of minor importance. These findings are at variance with the observations of other investigators.

E. A. POHLE, M.D.

The Electrical Charge of Erythrocytes as the Principal Factor of the Sedimentation Velocity. K. Brummer. Strahlentherapie, 1926, XXII, 322.

Effect of roentgen rays of long wave length on bacteria.—Although many experiments have been carried out to study the effect of roentgen rays on bacteria, this problem should be investigated in a systematic way. The author recommends the use of very long wave lengths, applying a tube potential of 10 K.V., with a current up to 50 ma. Choosing thin layers of bacteria and short target distance, the difference between entering and absorbed energy will be very small. The dose should be expressed in *R*-units. Experiments undertaken according to this outline proved that 21,650 *R* kill 100 per cent of a bacteria coli culture, and 75 per cent of a culture of staphylococci; 6,500 roentgen are lethal to 80 per cent of a culture of bacillus pyocyaneus. It is evident that these doses can never be applied to living tissues, but for the sterilization of instruments which can not be boiled or soaked in a chemical solution, this method may become of value.

E. A. POHLE, M.D.

The Significance of Soft Roentgen Rays for Experiments with Bacteria. O. Gaertner. Strahlentherapie, 1926, XXII, 327.

Tumors of cauda equina.—The delay which so often occurs in the diagnosis of tumors of the cauda equina is emphasized.

Two cases are reported in detail, in which diagnosis was first made on the basis of history and physical examination, and, afterward, confirmed by the injection of lipiodol into the cisterna magna. Excellent anteroposterior and lateral roentgenograms, showing the blocking of the canal by the tumors, are reproduced. The technic is given in some detail. Operative interference was carried out in both cases.

CHARLES D. ENFIELD, M.D.

Tumors of the Cauda Equina. Julian M. Wolfsohn and Edmund J. Morrissey. Jour. Am. Med. Assn., June 12, 1926, p. 1831.

Roentgen therapy of Hodgkin's disease.—After a brief review of the literature, the author gives a detailed account of twenty cases of Hodgkin's disease observed and treated with roentgen rays during the period from 1913 to 1925. He concludes that irradiation prolongs the life of these patients, and that there is no other therapeutic agent which gives as good results.

E. A. POHLE, M.D.

Lymphogranulomatose and Roentgen-ray Treatment. W. Brugmann. Strahlentherapie, 1926, XXII, 280.

Injected oils.—Lipiodol and iodipin were considered unsuitable by the authors for their work because of delayed absorption and a tendency to irritate and cause cicatrix formation.

In 67 cases, they have made injections into the seminal duct, usually on both sides, through vasotomy openings, and have made X-ray and bacteriological studies of the results. The two substances mentioned were found to be too viscous to enter readily into the vesicles, so mixtures of iodine and iodine compounds with animal oils were tried. Iodol, 20 per cent, in cod liver oil, and thymol iodide, 25 per cent, in cod liver oil, both simple mechanical mixtures, were found satisfactory from the standpoint of viscosity. It is stated that the injection of either clears the vesicles of gonococci and pyogenic bacteria. It is stated that neither produces irritation nor cicatrix formation.

While the authors have used these oils only

in work on the vesicles, it is suggested that they may be satisfactory substitutes for the more expensive and more viscous preparations, previously mentioned, in other fields.

Attention is called to the clinical importance of Bogros' space in the internal inguinal ring where the sheaths of the intrapelvic vas and the scrotal vas usually fail to meet in connection with, so called, industrial hernia.

CHARLES D. ENFIELD, M.D.

Roentgenography and Therapy with Iodized Oils. W. T. Belfield and H. C. Rolnick. Jour. Am. Med. Assn., June 12, 1926, p. 1831.

Irradiation of the brain.—In order to study the effect of roentgen rays on the growing brain, dogs four days of age were exposed four times every four days with two-thirds S.U.D. through 3 mm. Al. at 25 cm. F.S.D. The quality of the radiation is not recorded. Two months after the last treatment, the following abnormalities were observed: there was a definite retardation of the development compared with the untreated control animals; ataxia was present when walking; atrophy of the optical nerve appeared in the seventh week; an autopsy demonstrated the irradiated brain to be of smaller size; microscopically degenerative processes were seen in various parts, also slight hydrocephalus of the right hemisphere; the retina showed almost complete degeneration, only the part around the papilla seeming to be normal.

E. A. POHLE, M.D.

Animal Experiments with Roentgen Rays Administered to the Brain. R. Demel. Strahlentherapie, 1926, XXII, 333.

Deformity of normal air bubble.—Deformity of the normal air bubble by carcinomas in the upper third of the stomach is emphasized as a diagnostic point, and three roentgenograms showing such deformity, contrasted with one showing a normal air bubble, are reproduced.

CHARLES D. ENFIELD, M.D.

Deformity of the Air Bubble of the Stomach in Carcinoma. Jacob Buckstein. Jour. Am. Med. Assn., June 12, 1926, p. 1834.

Light protection of tannin.—A 10 per cent alcoholic tannin solution applied to the skin will prevent the appearance of an erythema after exposure to ultra-violet rays. The author has studied the mechanism of the effect and has come to the conclusion that a physical absorption of the radiation takes place and that the chemical action of tannin on the skin has nothing to do with the protective action.

E. A. POHLE, M.D.

To What is the Light Protection of Tannin Due? C. B. Hornicke. Strahlentherapie, 1926, XXII, 362.

A new device for Finsen light treatment.—The author describes a glass filter (blue uviol F-3,653, Schott & Gen., Jena) which is very transparent for wave length 4,050–3,340 Ångstrom. This part of the spectrum seems to have the beneficial effect on lupus vulgaris. An arrangement of quartz lenses, special carbon, high potential and current permits nearly three times an increase of intensity. The clinical results with this new method have been so far very encouraging.

E. A. POHLE, M.D.

Finsen Therapy of Lupus Vulgaris with Intensified Light and the Use of a Special Glass Filter to Absorb the Radiant Heat Rays. H. Haxthausen. Strahlentherapie, 1926, XXII, 337.

Biological comparison of roentgen rays and radium.—The author has compiled data as to the relation between age and roentgen ray or radium doses in women who were temporarily or permanently sterilized, noting the duration of the amenorrhea after administering the temporary sterilization dose. On this basis he calculated dosage tables, giving the dose of roentgen rays and radium required at any certain age to produce temporary sterilization of variable length or permanent sterilization.

E. A. POHLE, M.D.

Investigations of Biologically Equal Radium and Roentgen-ray Doses. G. H. Schneider. Strahlentherapie, 1926, XXII, 460.

Phenoltetraiodophthalein.—This article relates further experiences with the isomer of tetraiodophenolphthalein, with which the authors hoped to be able to perform, simultaneously, cholecystography and kidney and liver function tests.

The new dye had been given to fifty patients. It is said to give satisfactory gall-bladder shadows with smaller doses and, consequently, with less reaction than the older preparation. The maximum intravenous dose has been 2.5 grams, given in one dose in 30 c.cs. of distilled water. In three cases, there was slight dizziness; in the other forty-seven cases, no reaction of any kind. There has been no instance of thrombophlebitis in the series. Gall-bladder shadows are obtained four hours after injection.

It is not suitable for oral use. It does not give satisfactory kidney function readings. Experiments are being continued with still another substance, tetraiodoisophenolphthalein, which will be reported later.

CHARLES D. ENFIELD, M.D.

Cholecystography: The Use of Phenoltetraiodophthalein. Evarts A. Graham, Warren H. Cole, Glover H. Copher, and Sherwood Moore. Jour. Am. Med. Assn., June 19, 1926, p. 1899.

Undesirable roentgen-ray effects.—Heidenhain and Fried have recommended the treatment of inflammatory conditions of the adnexa with small doses (5 per cent S.U.D.) of roentgen rays. The author has tried this method in cases of gonorrheic origin but could not see any benefit; some of his patients were definitely worse after the exposure. He believes that a temporary sterilization is a much better therapy for this type of chronic pelvic inflammatory disease.

E. A. POHLE, M.D.

Regarding Some Undesirable Effects in Roentgen-ray Treatment of Benign Genital Diseases. G. H. Schneider. Strahlentherapie, 1926, XXII, 289.

Hyperemia and roentgen rays.—The effect of roentgen rays on the skin can be increased if hyperemia of the treated area is caused by diathermy, venous congestion, or sympathectomy. If diathermy is applied to the human skin fifteen minutes before roentgen-ray treatment, 30 to 40 per cent less roentgen energy is required to produce the same degree of erythema. In the cases where the dose was not reduced a severe reaction resulted. It was noticed that these injuries and even ulcers healed much quicker if the hyperemia was sustained; animal experiments supported these observations. A bad effect of anemia in the exposed area could not be demonstrated. The theory of this phenomenon is discussed and a careful and critical use of combined diathermy and roentgen-ray application in studying the real value of hyperemia recommended.

E. A. POHLE, M.D.

Hyperemia as Sensitizer for X-rays in Therapy. W. Wynen. Strahlentherapie, 1926, XXII, 503.

The roentgen photometer.—The authors have constructed a measuring instrument for use in roentgen therapy, built on the principle of the photometer. The radiation strikes a fluoroscopic screen at an angle of 45 degrees, passing through a tube to a Lummer-Brodhun prism, which at the same time reflects the light of a small colored electric bulb into the eye of the observer. The two fields to be compared are a central oval part and an outer ring without noticeable border line. A calibration chart comes with each instrument to permit a definition of S.U.D. or *R* units. The error is given as plus or minus 3 per cent. The maximum sensitivity appears to be at an average wave length of 0.3 Angstroms.

E. A. POHLE, M.D.

The Roentgen Photometer. H. Wintz and W. Rump. Strahlentherapie, 1926, XXII, 444.

Incipient tuberculosis.—The diagnosis of incipient tuberculosis in adults has been placed on a good foundation, but the diagnosis of incipient tuberculosis in children still remains an enigma. Physical signs are of little value in determining the diagnosis, since the main lesion is in the tracheobronchial lymph nodes, —a very inaccessible place for physical methods. The X-ray helps little, since, even though

adenopathy of the hilum glands be demonstrated, this may be due to many other causes, notably (1) whooping cough, (2) measles, (3) bronchopneumonia, (4) influenza, (5) chronic bronchitis, (6) lues, (7) Hodgkin's disease, (8) asthma, or (9) continuous upper respiratory infections, with sore throat. These often cannot be differentiated from tuberculosis.

Investigation has shown that positive skin tests of tuberculosis are not as conclusive among older children (6 to 14 years) as was formerly thought. Von Pirquet's estimation of 94 per cent positive reactions up to 14 years of age was for Vienna, where tuberculosis abounds: numerous instances are cited in this country where the rate is much lower. The authors believe this to be a most dependable method for diagnosis in cases where there is a definite history of contact and where enlarged tracheobronchial nodes are demonstraable.

L. R. SANTE, M.D.

The Diagnosis of Incipent Tuberculosis in Children. William H. Donnelly and Henry A. Reisman. Archiv. of Pediat., June, 1926, p. 386.

Determination of foreign body.—The author describes a simple and easy method of extracting needles and fish hooks if less than 2 mm. in diameter and more than 3 mm. in length. The method is inapplicable when there is evidence of active infection, or when the foreign body is close to easily injured structures, such as large blood vessels or nerves. After a preliminary X-ray examination to determine the position of the foreign body, a 2 per cent novocain-adrenaline solution is injected; a Record hypodermic needle of suitable caliber and fitted with a pear-shaped or conical metal plug, which serves as a handle, is thrust with aseptic precautions through a layer of sterile gauze into the skin and with the assistance of the fluorescent screen is entered in the axis of the foreign body, which is engaged by the needle point. With a little manipulation the foreign body is made to enter the lumen of the needle, and the needle is then withdrawn with the foreign body in its lumen. In the case of fish hooks and other barbed foreign bodies a larger needle is guided to engage the barb; a small incision may then be made and the entraction completed with forceps.

The author has removed needles from the knee joint with complete success; in one case the needle was broken off at the border of the patella, and in the second case it was broken and lying free in the joint. Both patients recovered full and painless movement of their knee joints.

Extraction of Needles and Fish Hooks. O. Susani. Zentralbl. f. Chir., March 27, 1926, p. 791. (Reprinted by permission from Brit. Med. Jour., June 19, 1926, p. 103 of Epitome of Current Medical Literature.)

Duodenal ulcer.—The author calls attention to the frequency with which duodenal ulcer occurs in association with partial obstruction at the duodenojejunal juncture. Fifty-four cases of duodenal ulcer have been relieved by surgical attention to this obstruction. Obstructions encountered were: Separation of jejunomesocolic band; separation of veins or light adhesions; severing all or part of the ligament of Treitz; partial resection of one leaf of the mesocolon, and a number of other pathologic lesions encountered.

Visualization of the duodenum by injection of air or warm bismuth solution through a Rehfuss tube is the usual means of arriving at the diagnosis of partial obstruction at the duodenojejunal portion. The author bases his conclusions on reverse peristalsis in the duodenum, where only a small amount of barium is present.

L. R. SANTE, M.D.

Duodenal Ulcer from Partial Obstruction at the Duodenojejunal Junction. Edwin P. Sloan. Am. Jour. Obst. and Gynec., April, 1926, p. 492.

FOR SALE—Victor Snook Transformer; Victor No. 7 table with fluoroscope attached; Wheatstone stereoscope. All in A No. 1 condition. Address L. S. Hunter, McDaniel Building, Springfield, Missouri.

THERE is a splendid opening for a competent roentgenologist in an Iowa city. Organized group assures good volume of work. This is a real position for the right type of man. Address, giving full particulars, A-28, c/o RADIOLOGY.